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Microstructure and porosity of Opalinus Clay at the Mont Terri rock laboratory (Switzerland)

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The Mont Terri rock laboratory (Canton Jura, Switzerland) is an international scientific platform of research on radioactive waste disposal in Opalinus Clay and results provide input for assessing the feasibility and safety of deep geological disposal of radioactive waste in argillaceous formations [1]. A main safety issue is to accurately investigate mass transport rates. To date several methods analyzed bulk permeability and porosity of Opalinus Clay. However, detailed quantitative investigation of microstructure and pore morphology is necessary to understand sealing capacity, coupled flow, capillary processes and associated deformation.

To produce high quality cross-sections without microstructural damage that enable investigation of microstructure and porosity down the nm scale a combination of Broad Ion Beam (BIB) milling and SEM imaging has been used [2]. This method allowed direct imaging of the clay fabric and porosity on ca. 1 mm2 areas.

The lateral variability of Opalinus Clay is low on the regional scale [1], whereas vertically the Opalinus Clay can be subdivided into six different lithological subfacies [3] based on variable silt layers, sandstone layers and siderite concretions present, where the end-members are the Shaly and Sandy facies. In this contribution microstructures and pore space in Opalinus Clay from the undisturbed Shaly and Sandy facies are studied and compared to disturbed samples from the "Main fault" within the Mont Terri rock laboratory.

The Shaly facies in the lower half of the sequence constitutes of dark grey silty calcerous shales and argillaceous marls, whereas the Sandy facies comprises silty to sandy marls with sandstone lenses cemented with carbonate [3]. The qualitative mineralogical composition of all Opalinus Clay facies is similar, whereas the "Main Fault" shows calcite, celestite and pyrite veins. Although the overall microfabric differs per layer and per facies we observe low variability of microstructure and porosity in each individual mineral phase. For example, pores in the clay matrix are distributed following a power law exponent of 2.3 regardless of the facies or cross-section. As a first qualitative result, pore morphology and microfabric varies towards faults, ranging from undisturbed to anastomosing fracture network in damage zones to even brecciated structures in fault cores containing various vein generations.

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