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BIB-SEM of representative area clay structures paving towards an alternative model of porosity

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A major contribution to understanding the sealing capacity, coupled flow, capillary processes and associated deformation in clay-rich geomaterials is based on detailed investigation of the rock microstructures. However, the direct characterization of pores in representative elementary area (REA) and below μm-scale resolution remains challenging. To investigate directly the mm- to nm-scale porosity, SEM is certainly the most direct approach, but it is limited by the poor quality of the investigated surfaces. The recent development of ion milling tools (BIB and FIB; Desbois et al, 2009, 2011; Heath et al., 2011; Keller et al., 2011) and cryo-SEM allows respectively producing exceptional high quality polished cross-sections suitable for high resolution porosity SEM-imaging at nm-scale and investigating samples under wet conditions by cryogenic stabilization. This contribution focuses mainly on the SEM description of pore microstructures in 2D BIB-polished cross-sections of Boom (Mol site, Belgium) and Opalinus (Mont Terri, Switzerland) clays down to the SEM resolution. Pores detected in images are statistically analyzed to perform porosity quantification in REA. On the one hand, BIB-SEM results allow retrieving MIP measurements obtained from larger sample volumes. On the other hand, the BIB-SEM approach allows characterizing porosity-homogeneous and -predictable islands, which form the elementary components of an alternative concept of porosity/permeability model based on pore microstructures.

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