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Influence of heterogeneity, anisotropy and induced damage on fluid flow in Bentheim sandstone

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Fluid flow in reservoir rocks is known to be complex in many ways, because of the heterogeneous and sometimes anisotropic nature of pore networks. Heterogeneity exists at all scales, from the grain scale to the reservoir scale where localized features such as fractures or compaction bands strongly affect fluid circulation patterns. Whether fractures act as conduits of barriers for fluid flow depends on the geological history and/or the tectonic environment of the reservoir. We present here some preliminary results on our ongoing study to characterize the interplay between fluid flow and the development of mechanical damage by combining several experimental techniques: capillary imbibition experiments under an industrial X-ray CT system, creep tests in a triaxial setup and image analysis. The methodology was as follows. In order to characterize fluid flow patterns in the intact rock, we conducted capillary imbibition experiments on Bentheim sandstone core samples with 4 cm diameter and 8 cm length under a medical scanner. The water front motion and pore filling was imaged nearly every second along a plane containing the symmetry axis of the core sample. The use of two sets of samples cored parallel or perpendicular to the bedding plane, respectively, revealed the anisotropic nature of fluid flow in the studied rock, as was already evidenced in former studies. The samples were then deformed at low confining pressure in a triaxial setup in creep experiments at a differential stress level close to the mechanical strength of the rock. The development and localization of damage was recorded using a 6-channels acoustic emission system. Then the damaged samples were tested again in capillary imbibition experiments combined with X-ray CT imaging. Finally image analysis tools were used to analyze and compare the CT images in both intact and damaged samples, in order to highlight the influence of heterogeneity, anisotropy and damage on flow paths in our Bentheim sandstone samples.