Geophysical Research Abstracts
Vol. 13, EGU2011-1454-1, 2011
EGU General Assembly 2011

X-ray imaging during capillary imbibition: a study on how compaction bands impact fluid flow in Bentheim sandstone

Adeline Pons (1,2), David Christian (2), Jérôme Fortin (1), Sergei Stanchits (3), and Jean-Marie Mengus (4)

(1) Laboratoire de Géologie, UMR 8538, ENS, Paris, France, (2) Laboratoire Géosciences et Environnement Cergy, Université de Cergy-Pontoise, 5 mail Gay-Lussac, F-95031 Cergy-Pontoise, France., (3) GFZ Potsdam, German Research Center for Geosciences, Telegrafenberg D423, D-14473 Potsdam, Germany, (4) IFP Énergies Nouvelles, 1-4 avenue de Bois-Préau, F-92852 Rueil-Malmaison, France.

In porous sedimentary rocks, strain localization commonly develops along shear bands or compaction bands. Whereas shear localization is associated with dilatant or compactive volumetric strain, compaction band is always associated with a drastic reduction in porosity, thus such a localized mode of failure can significantly impact the regional fluid flow.

To investigate the effect of compaction bands (CB) on fluid flow, capillary imbibition experiments were performed on Bentheim sandstone specimens (initial porosity $\sim$22.7%) using an industrial X-ray scanner. We used a three steps procedure combining 1) X-ray imaging of capillary rise in intact Bentheim sandstone, 2) formation of compaction band under triaxial tests, at 185 MPa effective pressure, with acoustic emissions (AE) recording for localization of the induced damage, and 3) again X-ray imaging of capillary rise in the damaged specimens after the unloading.

The experiments were performed on intact cylindrical specimens, 5 cm in diameter and 10.5 cm in length, cored in different orientations (parallel or perpendicular to the bedding). Analysis of the images obtained at different stages of the capillary imbibition shows that the presence of CB slows down the imbibition and disturbs the geometry of water flow. In addition we show that the CB geometry derived from X-ray density maps analysis is well correlated with AE location obtained during triaxial test.

The analysis of the water front kinetics was conducted using a simple theoretical model, which allowed us to confirm that compaction bands act as a barrier for fluid flow, not fully impermeable though. We estimate a contrast of permeability of a factor $\sim$3 between the host rock and the compaction bands. This estimation of the permeability inside the compaction band is consistent with estimations done in similar sandstones from field studies, but differs by one order of magnitude from estimations from previous laboratory measurements.