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Variation of petrophysical properties in deformation bands in calc-arenites (Leithakalk, Eastern Austria)

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In contrast to frictional faults and cataclasites in well consolidated and cemented sediments, lithologies with little or no diagenetic consolidation and high porosity develop deformation band type faults. Generally, deformation bands often form in well sorted fine to medium-grained sandstones before major porosity loss during diagenesis.
These deformation structures were studied at the Eastern border of the Eisenstadt Basin where deformation bands were found in Neogene calcarenites of the Leithakalk formation in a quarry near St. Margarethen (Eastern Austria). The Badenian Leithakalk in the quarry mainly comprises bioclasts dominated by corallinacaean debris and foraminifera.
The orientation of the deformation bands indicates E-W directed extensional kinematics which can be correlated to large scale horst-and-graben structures within the underlying basement and lower Miocene sedimentary rocks. Generally, the Leithakalk shows a primary porosity of around 30%, but within the deformation bands the porosity is reduced to $\sim$3%, showing no observable cataclastic grain size reduction, under the optical microscope or in micro-tomography data.
Thin section analysis of the same samples revealed a significantly lower amount of carbonatic cement within the deformation bands than in the undeformed limestone. However, only in cathodoluminescence images the observation of fractured bioclast grains healed by fine grained cement provides evidence of cataclastic deformation.
Furthermore, the permeability across selected deformation bands was measured with a minipermeameter. The deformation bands itself has almost zero permeability due to the decreased porosity. The permeability is 50-100 times reduced in contrast to the nondeformed rock fabric.
Three 3 x 3.5 cm sized drill core containing a deformation band each, were analyzed using X-ray micro-tomography with a spatial resolution of 30 microns. The pores outside the deformation band are 500-2000 microns in diameter, and show a well connected pore space. In contrast, the size of pores is strongly reduced within the deformation band to a maximum of 100 microns; the pores are clearly isolated and fill < 3 % of the volume inside the deformation band. A decrease of up to one magnitude of porosity is shown.
Using detailed X-Ray tomographic data of porosity within and outside the deformation bands, in combination with microstructural investigations, we are able to constrain the deformation mechanisms and relative timing of deformation with respect to the cementation of the limestone.