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Mechanical and mineralogical modifications of petrophysical parameters by deformation bands in a hydrocarbon reservoir (Matzen, Austria)

Jasmin Kaiser (1), Ulrike Exner (1), Susanne Gier (1), and Wolfgang Hujer (2)
(1) Department of Geodynamics and Sedimentology, University of Vienna, Austria, (2) OMV, LEP-FC, Vienna, Austria

In porous sedimentary rocks, fault zones are frequently accompanied by deformation bands. These structures are tabular zones of displacement, where grain rotation and in some cases grain fracturing result in a significant reduction in porosity.
Core samples were analyzed close to large normal faults from the most productive hydrocarbon reservoir in the Vienna Basin (Austria), the Matzen oil field. The Badenian terrigeneous sandstones contain predominately quartz, feldspar and dolomite as sub-rounded, detrial grains and are weakly cemented by chlorite and kaolinite. Deformation bands occur as single bands of ca. 1-3 mm thickness and negligible displacement, as well as strands of several bands with up to 2 cm thickness and displacement of 1-2 cm. A dramatic porosity reduction can already be recognized macroscopically. In some samples, the corresponding reduction in permeability is highlighted by different degree of oil staining on either side of the bands.
The mineralogical composition of the deformation bands compared to the host rock does not indicate any preferential cementation or diagenetic growth of clay minerals or calcite. Instead, clay minerals are slightly enriched in the host sediment. These observations suggest that the formation of deformation bands predates the cementation in the Matzen sands. Thus, we speculate that the porosity reduction is predominately caused by cataclastic grain size reduction.
Identification of the grain scale processes of porosity and permeability reduction, in combination with the analysis of the spatial distribution and orientation of the deformation bands may provide valuable information on the reservoir properties and fluid migration paths.