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Distribution of sub-seismic deformation near faults - Implications for Tight Gas production

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Increasing the efficiency of hydrocarbon production from tight gas reservoirs is becoming increasingly important for the Rotliegend Sandstone reservoirs of NW Europe. As part of a multidisciplinary project to produce tight gas more efficiently, we focus on deformation structures forming seals, baffles or pathways for hydrocarbons. The aim of this project is to better understand the distribution of the sub-seismic deformation structure types, such as deformation bands and fractures, and their impact on flow around non-planar faults. Recent studies have shown that faults are not as planar as previously assumed. Furthermore, the exact microstructural type of deformation structure exerts a strong control on the flow behavior. However, the spatial distribution of these structures in respect to the shape of larger structures is not well understood.

The Entrada Sandstone (SE Utah, USA) is very similar to the Rotliegend Sandstone and is well exposed. During a 2010 field campaign we studied faults and related deformation structures on two different areas: the Klondike Bluffs area which is characterised by minor cataclasis and strong diagenesis and the Courthouse Junction area which is characterised by major cataclasis and less diagenetic alteration. Based on scanline measurements and rock samples we analysed the spatial distribution of the different types of deformation structures and features that are created as a result of fluid flow (i.e. concretions) in relation to the master fault. It can be seen that in both areas the deformation band density decreases away from the faults. Comparing the two studied areas we show that the average number of deformation bands per meter is significantly higher on the Klondike Bluffs area than on the Courthouse Junction area.

The deformation structures on the different areas show significant microstructural differences. On the Courthouse Junction area cataclastic deformation bands are generally considered to be baffles for fluid flow and we observe this effect in the field as well. Furthermore, they generally are stronger than their host rock. In the Klondike Bluffs area, there is a significant increase of porosity, inside the dislocation deformation bands allowing the fluid flow. These bands are weaker than their host rock.

Microstructural analyses, combined with BIB-SEM poro/perm measurements of samples, allow us to help predict the deformation related permeability distribution around faults.