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Effects of cementation and alteration on deformation band evolution in arkosic sediments

LOMMATZSCH, M.[1], EXNER, U.[2], GIER, S.[1], GRASEMANN, B.[1]

[1] University of Vienna, Department for Geodynamics and Sedimentology, Althanstraße 14, 1090 Vienna, Austria
[2] Department of Geology and Paleontology, Museum of Natural History Vienna, Burgring 7, 1010 Vienna, Austria

Porous sediments can develop narrow zones of deformation as a response to surrounding stress. These tabular zones of localized deformation are commonly described as deformation bands. Deformation bands usually show small displacements and are restricted to high porosity rocks, where the amount of free pore space facilitates deformation processes like grain reorganization, smearing and fracturing. Cataclastic shear bands are characterized by grain fracturing, which leads to grain-size, porosity and permeability reduction in comparison with the adjacent host rock. The changed petrophysical properties in the deformation bands can influence or inhibit fluid flow in hydrocarbon or groundwater reservoirs.

The present study examines cataclastic shear bands with varying deformation and alteration mechanisms which developed in heterogeneous sediment deposits under identical kinematic boundary conditions. The investigated outcrop near Eisenstadt (Austria) is located at the northern margin of the Eisenstadt-Sopron Basin. The quarry exposes numerous conjugate deformation bands, which are formed in lower Miocene arkosic sediments. The uncemented host sediment consists of detrital quartz, albite, biotite, sericite, muscovite, bioclasts and metamorphic lithoclasts. We distinguished several types of deformation bands which differ in shape, orientation, composition, grain size, cementation and sealing capacity. The dominant deformation mechanisms and influence on fluid flow are controlled by the initial composition, cementation and intensity of diagenetic alteration. We identified different evolutionary stages from a high-porosity host rock (Φ = 35%) to deformation bands (Φ = 6%) acting as fluid baffles. The timing and direction of the specific fluid flows can be determined by the interaction with the deformation bands.