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Extensional fault zone architecture and deformation band scaling properties in high-porosity sands: example from the Crotone basin (south Italy)

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We describe the evolution of the structural architecture of deformation-band-dominated extensional fault zones developed at shallow depth (<1 km) in high-porosity (>10-15%) feldspar lithoarenites (200 μm < mean grain size < 800 μm) in forearc setting. The displacement of the studied fault zones varies between few cm up to $\sim$100 m. Fault zones typically consist of a narrow fault core surrounded by thick damage zones which, in turn, contain abundant fault-parallel deformation bands. Fault core and damage zone thickness tend to increase with increasing displacement. The main deformation mechanism in fault cores is particulate flow, with a variable amount of mechanical grain size reduction that progressively increases with increasing fault displacement. The formation of deformation bands involves cataclasis and porosity collapse. XRD analyses performed on both undeformed and faulted sands show a slight increase of phyllosilicates in the fault core rocks, whereas the deformation bands do not show significant mineralogical variations with respect to the host sands. Fault cores and deformation bands show permeability reduction with respect to the host sands up to 3-4 orders of magnitude. The number of deformation bands in damage zone increases with increasing fault displacement. The spacing between adjacent deformation bands, as well as the width of each deformation band, do not show any relationship with fault displacement. They are controlled by the mean grain size of host sands: deformation bands are more closely spaced and thinner in fine sands than in coarse sands. The characterization of the structural and petrophysical architecture of such extensional fault zones provides the basis for transmissibility calculation as a function of fault displacement which may help to predict the hydraulic behaviour of faulted clastic reservoirs and aquifers.