Influence of Stress and Temperature on Fault Rock Properties in Impure Sandstones

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Primary controls on fault rock properties include clay content, stress history, stress magnitude during faulting and temperature-driven diagenetic reactions. The influence of the aforementioned controls on phyllosilicate framework fault rocks (PFFRs) was investigated in a study of reservoir sandstones and associated faults from the eastern and western Otway Basin. In the eastern Otway, grain mixing and shear-induced clay compaction during shallow (low stress) faulting has increased fault threshold pressures and decreased permeability relative to host reservoir strata. These processes led to a greater proportion of rigid framework grain contacts, resulting in increased bulk friction coefficients relative to host reservoir rocks. PFFRs form dense clusters of faults as a result of strain hardening and preferential localisation of new faults in weaker reservoir sandstone. Mechanical and diagenetic processes in western Otway PFFRs, formed during a deep, high-stress faulting event, have also significantly altered fault rock properties. Faults exhibit increased friction coefficient and threshold pressures and decreased permeability due to more efficient grain packing, suturing of quartz grains and fracture healing. PFFRs from both regions appear significantly stronger than their host reservoirs as a direct result of syn- and post-deformational physical and diagenetic processes. These findings have direct implications for understanding micromechanics of deformation in impure sandstones, physical property evolution syn-/post-faulting and for geomechanical prediction of fault reactivation. In a regional context, the regeneration of fault strength influences stress distribution in regional top seals that has resulted in fracturing and loss of hydrocarbons but the influence of PFFRs on compartmentalization is less clear.