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Fault Seal and Conduit Dichotomy: Impact of Deformation Mechanism and Fault Geometry

Two different deformation mechanisms accommodate faulting in Jurassic sandstone units along the Moab fault (~1 km normal offset) in Utah, USA. These mechanisms are (1) the formation of deformation bands resulting from cataclastic shear failure of porous sandstone, and (2) the formation and subsequent shearing of joints producing splay fractures and breccia. We observe that deformation bands are prevalent along the entire length of the fault system. Deformation band density is greatest within contractional relays between fault segments. In contrast, the formation and shearing of joints only develops at intersections and extensional relays between fault segments. Joints consistently overprint deformation bands. Changes in faulting mechanism or structure density are observed at structurally complex locations consistent with local variations in stress state associated with fault slip.

Sandstone adjacent to fault intersections and within extensional relays is extensively cemented by calcite and quartz. These cements are located in or adjacent to joints and breccia zones consistent with focused fluid flow through the parts of the fault overprinted by joints and sheared joints. Thus, areas of focused fluid flow coincide with the development of dilational, joint-based, fault architecture. We conclude that the faulting mechanism and segmentation of a fault controls the variation of fault architecture in sandstone and thus the permeability structure of a fault system.