

Relationships Between Fractures, Faults, and Production

John C. Lorenz and Scott P. Cooper

Vertical Transmissive Faults/Fractures (VTF's) provide important heterogeneities in reservoirs even though their presence may not be obvious in geologic or seismic datasets. Such features explain production anomalies such as unexpected interference between wells, virgin-pressure zones within otherwise depleted reservoirs, and heterogeneous fluid chemistries in seemingly homogeneous reservoirs. VTF's, forming as fault-related fracture zones, can develop along normal and strike-slip faults in otherwise minimally-deformed strata, and in the strata overlying basement faults. The local stresses created along and adjacent to these faults fracture the rock, creating tabular systems of well-developed and interconnected fractures, sometimes referred to as fracture halos, corridors, or swarms.

The fracture corridors along the faults are commonly open, permeable, and interconnected, forming fracture-controlled pathways that account for localized sweet spots at different scales within reservoirs, oilfields, and basins. However, mineralization can precipitate in the fracture apertures locally when external fluids with incompatible chemistries, sometimes from deep basement sources, are introduced into the formation to mix with the local formation fluids.

The identification of VTF's requires a multidisciplinary approach that uses engineering, geophysical, and geological data. Engineering data commonly provide non-unique interpretations but can be constrained by geologic data. VTF's can be of a size that is below seismic resolution, but can often be recognized in subtle attributes of seismic datasets. Aerially-limited geologic data from cores and wells may not provide direct evidence for small-scale faults, but do provide a reality-based rationale for interpreting engineering/production anomalies and geophysical attributes. The problem is complicated by the fact that faults, fractures, and VTF's can change character as they cut through different layers with varying geomechanical and geochemical properties.