

Case History #3: Fault/Fracture-Controlled Production in the San Juan Basin

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Fractured reservoirs in the San Juan Basin of northwestern New Mexico are associated with faults and associated fractures that formed during north-northeast to south-southwest shortening of the strata during the Laramide orogeny. Additional right-lateral strike-slip motion along pre-existing basement faults at the eastern and western margins of the basin formed the Hogback monocline and the Nacimiento uplift, creating Vertically Transmissive Faults (VTF), marked by springs at various locations along their trace length.

Regional-scale fractures as well as fractures associated with local structures can interact with fault zones. These background fractures will feed additional fluids from the reservoir into the fault zone. Simplistically there are three possible Fault-Fracture relationships:

1. A fracture system may form at the same time as a fault.
2. A younger fracture system may be superimposed onto a fault.
3. A fault may be superimposed onto a pre-existing fracture system.

A combination of these conditions is also possible, and such a system evolved in the Rio Puerco Fault Zone at the southwestern corner of the basin, where an early set of fractures was reactivated when a younger, extensional fracture and fault system was superimposed onto the strata. These faults and associated fractures are outcrop analogs to subsurface Vertically Transmissive Faults/Fractures within the Dakota Sandstone in the deeper parts of the basin.

The outcrop faults/fractures range in throw and length, but the two parameters are generally proportional to each other. As fault throw increases local fracture intensity and the width of the fracture zone also increase. It is necessary to use the best exposures along different faults to document, from small to large, the successive degrees of deformation in order to build a composite model of the fracture continuum that develops as throw changes along the strike of any given fault of variable throw. This is the pattern that is present in subsurface reservoirs, as documented in 3-D seismic data and by a well-constrained example of production interference between two wells along a Transmissive Fault.