The Prediction of Permeability Enhancing Fracture Patterns within Natural Gas Reservoirs Based on Outcrop Characterization Near Normal Faults; Wind River Basin, Wyoming

Hutch Jobe*
ConocoPhillips, Midland, TX, United States
tracy.h.jobe@conocophillips

Randy Herr
ConocoPhillips, Midland, TX, United States

and

Paul MacKay
Geoconsultants Ltd., Calgary, AB, Canada

The intensity of natural fractures tends to increase near fault planes. These damage zones exist both on the up-thrown and down-thrown sides of normal faults but fracture distribution within the damage zones can vary. Damage zone widths appear to be a function of fault displacement. Faults with at least 100' of vertical displacement can generate damages zones that extend hundreds of feet away from the fault trace. Outcrop evaluation from the Cretaceous aged strata of the Wind River Basin as well as subsurface analysis within the basin supports this conclusion. Understanding fracture trends, intensity, and orientation associated with normal faulting, can help enhance the ability to predict where fractures may occur in the subsurface when dealing with low permeability gas reservoirs. Fractures influence reservoir trap dynamics such that conventional 4-way structure closure may not be necessary.

The Upper Cretaceous (Cenomanian) aged Frontier Formation in the foothills of the Owl Creek Mountains is an excellent exposure for fracture characterization. The highly productive shoreface sequences of the Frontier Formation outcrop sub-parallel to depositional strike which, coincidently, is perpendicular to a series of normal faults of varying displacements. This geometry allows for characterization of fractures in both the footwall and hanging-wall positions. Damage zone thickness and fracture intensity variation can be documented.

The upper 350' of the Tertiary (Paleocene) Lower Fort Union Formation (LFU) located in off-structure positions at the Madden field, has had significant gas shows. The shows are located within an inter-bedded sequence of tight dirty sandstones, coals, shales, and siltstones (possibly coastal plain) and had been regarded as "coal" or "fracture" gas of limited aerial extent. For the

most part, these assumptions were accurate, except where fractures have created drainage areas large enough to provide commercial production. The damage zone architecture associated with the extensional faulting at the top of the LFU has fracture domains that extend the drainage area of the wellbore such that wells have estimated ultimate recoverable reserves (EUR) of up to 5.0 BCFG at depths of less than 7000 feet.