Impacts of Diverse Fluvial Depositional Environments on Hydraulic Fracture Growth in Tight Gas Reservoirs

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After more than 60 years of hydraulic fracturing, many aspects of fracture growth are still not completely understood. One such area is the how the depositional environment affects hydraulic fracturing growth, particularly in complex fluvial reservoirs. Fracture diagnostic techniques, such as microseismic and tiltmeters, yield tangible illustrations of how hydraulic fractures propagate in such reservoirs. However, the absence of detailed reservoir models from a petrophysical and geologic standpoint makes it difficult to fully understand the reasons for certain fracture growth and the impacts on reserve recovery, especially when model simplification is a common practice.

This study analyzes the impact of depositional environments and the associated heterogeneities on hydraulic fracturing growth in fluvial tight gas reservoirs, using hydraulic fracturing simulator software based on a fully 3-D meandering fluvial tight gas geologic model developed deterministically and stochastically from an outcrop. Petrophysical properties and reservoir conditions in the models are based on subsurface data from nearby producing fields with comparable fluvial systems.

Different well locations within the 3-D geologic model capture various sandstone body lateral changes and vertical distributions, including proportions of intervening mudrocks. A range of hydraulic fracture orientation planes, associated with these well locations, are selected and various stimulation model sensitivities run. The detailed geologic model, which differentiates between sandstone bodies such as crevasse splays, crevasse channels, and point bars as well as different types of mudrock facies, includes varying reservoir parameters such as permeability, porosity, rock mechanical properties, etc., for five basic rock types distributed within various bodies. The effect of varying architectures on fracture growth for the different case scenarios is discussed, and the set of conditions that provides maximum production and reserves recovery when hydraulic fracturing this type of unconventional play is also defined.