The Role of Matrix and Fractures on Appalachian Basin Upper Devonian Gas Production

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Long-standing debates have surrounded the relative contribution of natural fractures and matrix to the prolific production of very low permeability, low pressure reservoirs such as the Upper Devonian Shales of the Appalachian Basin. The Upper Devonian Shales are composed of several black shale intervals that have been exploited for hydrocarbons for over 100 years, including the Dunkirk and Rhinestreet shales. Gas storage efficiency and movement of gas through these shales needs to be viewed in three different time frames and conditions: geologic via hydrocarbon migration, formation connectivity via natural wellbore production, long-term production via artificial fractures connecting a larger area.

The notion that gas-filled fractures abound in the subsurface at a lateral spacing often missed during coring and logging operations is not supported by the characteristics of most shale gas producing wells. Shale wells typically do not produce without stimulation unless a set of tectonically-related faults and fractures are intersected along the wellbore. Observations from four wells drilled in southern West Virginia where data was collected on four different lithologies highlight the importance of matrix versus fracture abundance in creating economically-viable reservoirs. The following reservoirs were analyzed for matrix versus fracture contribution during geologic time, natural wellbore production time, and long-term production post stimulation: porous and permeable (millidarcy scale) sandstone, porous and impermeable (nanodarcy scale) siltstone, organic rich shale, and organic lean shale.