Quantifying Opening-Mode Fracture Spatial Organization in Horizontal Wellbore Image Logs, Core and Outcrop: Application to Upper Cretaceous Frontier Formation Tight Gas Sandstones, USA

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ABSTRACT

The spatial arrangement of natural fractures can influence the success of many exploration and development procedures. For example, fractures can affect drilling rates and lost circulation patterns. In most unconventional plays, anticipating such variations can potentially have a very marked economic impact owing to the large numbers of horizontal wells drilled. Moreover, numerical modeling of hydraulic fracture growth is hampered if natural fractures affect hydraulic fracture growth and knowledge of spatial organization of the natural fractures is unknown. Natural fractures are probably not randomly arranged. Available evidence suggests that they may range from apparently random, to systematically clustered (in a range of patterns) to approximately evenly spaced. Quantifying what pattern exists in a given play has practical benefits, and rigorously documenting the types of natural spatial arrangement patterns is useful for guiding predictive model development.

Here we use the Marrett CorrCount normalized correlation count method for quantifying and predicting the spatial organization of natural fractures at a range of scales in the Cretaceous Frontier Formation, a tight gas sandstone in Wyoming. We make use of natural fracture data from horizontal image logs and core, as well as long outcrops that contain fractures that are probably representative of the subsurface. Horizontal image logs provide an opportunity for characterizing spatial arrangement of fractures and faults. Comparison of image log and core allows calibration of fracture picks in the logs. In lower shoreface sandstones of the Frontier Formation, fracture clusters ~35 m wide are spaced either ~ 50 or ~ 90 m apart for the oldest E-W striking set. Organization within the clusters is fractal.

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