NATURAL FRACTURE CHARACTERIZATION AND PREDICTION IN UNCONVENTIONAL RESERVOIRS OF THE "MISSISSIPPIAN LIMESTONE", NORTH-CENTRAL OKLAHOMA, USA

Yulun Wang
Oklahoma State University, Geology, Stillwater, OK, USA
yulun.wang@okstate.edu

ABSTRACT

Natural fractures are common in several unconventional carbonate reservoirs in both the U.S. and around the world. Although many are sealed, these natural fractures may assist in the propagation of induced fractures during hydraulic fracturing and, therefore, are an important component for characterizing and producing from these reservoirs. This study is focused on correlating fracture types and intensity to petrophysically-significant facies and to an established sequence stratigraphic framework in the unconventional "Mississippian Limestone" in north-central Oklahoma. Four types of natural fractures are observed: ptygmatic, vertical extension, shear, and mixed types of fractures, with the ptygmatic fractures being the most abundant type. Most of the fractures are sealed with calcite cement. Fractured zones are both laterally and vertically heterogeneous at various scales, indicating variability in rock mechanics. Within individual cores, fractures are commonly discontinuous and exhibit variable widths at the millimeter scale, as revealed by thin sections and micro-CT imaging. At the centimeter scale, ptygmatic fractures exhibit variable termination patterns in relation to bedding planes, suggesting a mineralogical control on fracture propagation and rock mechanics. At the meter scale, the highest fracture abundance corresponds to facies with the highest calcite content, and consequently, to the regressive phases of "third-order" sequences which are commonly defined by these facies. Laterally, fracture abundance varies among individual cores, likely attributed to variations in the proportion of petrophysically significant facies, variations in structural settings throughout the region, variable patterns in the evolution of rock mechanics, and clustered fracture distribution related to the geographic separation of the cores. Although there is a potential mismatch between the present-day fracture stratigraphy and the mechanical stratigraphy at the time of fracturing related to evolution of rock mechanics (e.g., structural diagenesis), the sequence stratigraphic framework, which governs the distribution of petrophysically significant facies and impacts the evolution of diagenesis and rock mechanics, can provide insight that may enhance the prediction of natural fracture distribution in these and other unconventional mixed carbonate-siliciclastic reservoirs.