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A pore-scale perspective on the hydraulic fracturing of heterogeneous glutenites

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Hydraulic fracturing is one of the most important technique for the development of tight glutenite reservoirs. The strong heterogeneity of the sand and gravel particles make it difficult to comprehensively understand the fracturing mechanisms of glutenites. Most of the existing studies have been mainly focused on the effects of injection rate[1], stress differential[2], and fracturing fluid viscosity[3], However, there still lacks a systematic consideration of the impact of glutenite heterogeneity especially on the aspects of matrix and gravel bonding interface strength and gravel mechanical properties.
Therefore, the aim of this study is to reveal the effects of interface bonding strength and gravel properties on the fracture evolution of glutenite at the pore scale. The heterogeneity of the matrix, gravel particle, and interface strength are considered by a global cohesive zone model. Heterogeneity is achieved by assigning different strengths and critical fracture energies to the cohesive elements of matrix, gravel, and interface. The simulation is validated by comparing the results with existing experimental observations[4].
We first discussed the fracturing of a model glutenite with the same size gravel particles but different interface bonding strength and gravel properties. We established a phase diagram to fast evaluate the crack propagation mode by using the ratios of critical tensile energy of gravel to matrix and matrix to surface. To get closer to the real glutenites, we also considered more complexed glutenites composed of three kinds of gravels with different sizes, bonding strengths and mechanical properties. Modeling results indicate that hydraulic fractures tend to propagate along the path with the minimum critical fracture energy. The differences in strength between gravel and interface lead to alterations in the propagation path and speed of hydraulic fractures, significantly impacting the length of hydraulic fractures.

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Primary authors: CHEN, yanying (School of Civil and Resource Engineering, University of Science and Technology Beiing,); SONG, Hongqing (School of Civil and Resource Engineering, University of Science and Technology Beiing); XIE, Chiyu (School of Civil and Resource Engineering, University of Science and Technology Beiing)

Presenter: CHEN, yanying (School of Civil and Resource Engineering, University of Science and Technology Beiing,)

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