Debate: What does the stimulated fracture geometry in shale 'look-like', and what is the most appropriate way to model them?

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Abstract

We open this miniseries with a topic that has been discussed in the industry long above the shale revolution - fracture complexity. You might remember a famous paper by Norm Warpinski et al (SPE-22876-PA, 1993) and a less known but very powerful response by Ken Nolte (published as a rebuttal to the original paper). There is still a lot of uncertainty about the complexity of hydraulic fractures and its importance for engineering applications even 30 years later. Therefore, the topic of the first debate is "**What does the stimulated fracture geometry in shale 'look-like', and what is the most appropriate way to model them?**"

We are very lucky to have two very prominent members of our community accepting the invitation to debate on this subject. Ahmad Ghassemi will defend a view, which is closer to the original position of Norm Warpinski:
“Historically, hydraulic fracturing design originated in conventional oil/gas resources with the concept of a single planar fracture propagating in the maximum stress direction. With the development of tight gas formations, more complex geometries (featuring multiple parallel, branching, and segmented fractures) emerged, which later evolved into the concept of complex fracture

networks (e.g., in the Barnett shale). Although recent experiments in unconventional shales often point to a complex stimulated volume, the prevailing concept continues to be that of a single planar hydraulic fracture, frequently suggested by fiber data. Often, the complexity is acknowledged using the fuzzy and somewhat evasive “fracture corridor” terminology. The outlook is reinforced by limited modeling capabilities, lack of sufficient data, and practical expediencies. The complexity or lack thereof is ultimately determined by the interaction of the in-situ stress and rock structural/fabric characteristics, as demonstrated by laboratory experiments, field observations, and numerical modeling. While the single frac model may be well suited for certain shale plays (e.g., Wolfcamp), its injudicious adoption for application to other fields likely is an oversimplification of the complex reality.”

Mark McClure (CEO and co-founder of ResFrac corporation) will support the view, which is closer to Nolte’s response 31 years ago:
“The large majority of the time, hydraulic fractures in shale are predominantly 'planar' at field scale (forming swarms of subparallel hydraulic fractures), and 'complex' at small-scale. In a field-scale model, they are best modeled as planar, with adjustments to the constitutive relations to account for the effects of small-scale complexity. Occasionally, hydraulic fracture swarms are captured by a high-permeability fault, and in this situation, it can be appropriate to include the fault as a 'discrete fracture' in the model. True 'DFN' modeling of hydraulic fracturing in shale is rarely the correct choice, either practically or as a representation of what the fractures actually look like.”

Each speaker will be given time to present his position and key supporting arguments in the opening statements. Then we will let them question each other and open the floor to the audience for Q&A. So, please come prepared!

Bios

Ahmad Ghassemi is the McCasland Chair Professor in the Mewbourne School of Petroleum & Geological Engineering, OU and is the director of the Halliburton Rock Mechanics Laboratory. He has a Ph.D. in Geological Engineering and specializes in geomechanics for unconventional petroleum & geothermal & reservoir development. He has been working on hydraulic fracturing and high-temperature rock mechanics research for the past 25 years with emphasis on modeling of multiple hydraulic fractures, coupled geomechanics/fluid flow modeling in naturally fractured reservoirs, wellbore stability analysis, induced seismicity, and experimental determination of reservoir rock properties. His teaching interests include reservoir geomechanics, numerical modeling, petrophysics, and stimulation.

Mark McClure established ResFrac in 2015 to help operators maximize value through the application of advanced geomechanics and reservoir simulation. Before founding ResFrac, Mark was an assistant professor at the University of Texas at Austin in the Department of Petroleum and Geosystems Engineering. After earning a Bachelor of Science in chemical engineering and a Master of Science in petroleum engineering from Stanford University, Mark earned a PhD in energy resources engineering at Stanford.