Multiscale Tip Asymptotics for a Deflating Hydraulic Fracture with Leak-off

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Emmanuel Detournay is the Theodore W Bennett Chair Professor in Mining Engineering and Rock Mechanics in the Department of Civil, Environmental, and Geo- Engineering of the University of Minnesota (UMN). His presentation will be at 9:00 Central Time on Thursday, January 26, 2023. The topic is **"Multiscale Tip Asymptotics for a Deflating Hydraulic Fracture with Leak-off"**

Abstract

The talk deals with the construction of the tip asymptotes for a hydraulic fracture deflating in a permeable elastic medium [1]. Specifically, we describe the changing nature of the asymptotic fields during the arrest and recession phases following propagation of the fracture after fluid injection has ended. We show that, as the fracture deflates in the arrest phase, the region of dominance of the LEFM tip asymptote $w \sim x^{1/2}$ of the fracture aperture w with distance x from the front shrinks to the benefit of an intermediate asymptote $w \sim x^{3/4}$. Hence only the velocity-independent 3/4 asymptote is left at the arrest/recession transition. Furthermore, with increasing receding velocity of the front a linear asymptote $w \sim x$ progressively develops at the fracture tip, with $w \sim x^{3/4}$ again becoming an intermediate asymptote. These universal multiscale asymptotes for the arrest and the recession phases are key to determining, in combination with a computational algorithm that can simulate the evolution of a finite fracture, the decaying stress intensity factor during arrest, the time at which the fracture transitions from arrest to recession, and the negative front velocity during recession.

[1] A. Peirce and E. Detournay (2022), Multiscale Tip Asymptotics for a Deflating Hydraulic Fracture with Leak-off, *Journal of Fluid Mechanics*, 947: A17, doi: 10.1017/jfm.2022.623

Biography

Emmanuel Detournay is currently the Theodore W Bennett Chair Professor in Mining Engineering and Rock Mechanics in the Department of Civil, Environmental, and Geo- Engineering of the University of Minnesota (UMN). He holds a mining engineering degree from the University of Liège, Belgium and MSc and PhD degrees in Geoengineering from the UMN. Prior to joining the UMN in 1993 as a faculty, he held various positions in consulting companies (Itasca, Minneapolis, MN; Agbabian Associates, El Segundo, CA) and in R&D (Dowell-Schlumberger, Tulsa, OK; Schlumberger, Cambridge, England).). His expertise is in petroleum

geomechanics, with two current research focuses: drilling mechanics (bit/rock interaction, self-excited drilling vibrations, drillstring/borehole interaction, and directional drilling) and mechanics of fluid-driven fractures (asymptotic analysis, scaling, numerical modeling). He has co-authored about 140 papers in refereed publications. He also been awarded 9 US patents and has received several scientific awards for his work. In 2016 he was elected into the US National Academy of Engineering.