A Unified Temporal-Spatial Scaling Law for Hydraulic Fracturing in Layered Rock Formations

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Dr. Hao Yu is an Associate Professor at the University of Science and Technology of China (USTC). He will speak on Thursday, August 20, 2026, at 9:00 a.m. Central Time. The topic is “A Unified Temporal-Spatial Scaling Law for Hydraulic Fracturing in Layered Rock Formations.”

Abstract

Hydraulic fracturing in layered rock formations exhibits complex propagation behavior due to the coupled effects of layer thickness, material contrasts, and interface-induced disturbances. Existing scaling laws developed for homogeneous formations cannot fully describe the non-self-similar evolution of hydraulic fractures across heterogeneous layers. This presentation introduces a unified temporal-spatial scaling law for plane strain hydraulic fracture propagation in layered rocks. By incorporating variations in elastic modulus, fracture energy, and in-situ stress across interfaces, a dimensionless framework is developed based on modified singular integral equations, dynamic crack-tip asymptotics, and newly defined characteristic scales associated with fracture evolution and layer thickness. The proposed model captures the transition between toughness-dominated and viscosity-dominated propagation regimes induced by interfaces and integrates the effects of elastic properties, fracture resistance, fluid injection conditions, injection time, and layer thickness. The resulting scaling law provides a unified description of hydraulic fracture propagation in homogeneous, single-interface, multilayer, and homogenized layered formations, offering a theoretical framework for modeling hydraulic fracturing in complex heterogeneous reservoirs.

Biography

Assoc. Prof. Hao Yu is an Associate Professor in the Department of Modern Mechanics at the University of Science and Technology of China (USTC). He received his Ph.D. degree in Solid Mechanics from USTC in 2021. His research focuses on computational mechanics, numerical methods, and their applications in deep unconventional energy development. His research outcomes have been implemented in major state-owned enterprises and leading energy companies. He has led multiple national research projects and industry-funded R&D programs. He has published over 50 SCI papers as first or corresponding author in leading journals, including PRL, JMPS, CMAME, IJNME, Sci. Adv., PNAS, IJSS, IJES, and J. Petrol. Sci. Eng. His research has been recognized by the Anhui Province Science and Technology Progress Award, the Chinese Academy of Sciences President Award, and inclusion among the World’s Top 2% Scientists.