Application of continuous wavelet transform (CWT) for hydraulic fracture diagnostics

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Thursday, October 5, 2023, 9 a.m. Central Time

Mohamed Adel Gabry is a Ph.D. candidate at the University of Houston. His presentation will be at 9:00 Central Time on Thursday, October 5, 2023. The topic is **"Application of continuous wavelet transform (CWT) for hydraulic fracture diagnostics."**

Abstract

The Continuous Wavelet Transform (CWT) is a powerful signal processing technique that functions as a mathematical microscope, enabling the detection of subtle changes in any signal. It has the potential to revolutionize hydraulic fracturing diagnostics by employing advanced signal processing methods to analyze the output signal of hydraulic fracture systems, particularly pressure data, in order to gain insights into their properties. One key application of the continuous wavelet transform is the identification of fracture closure time, marking the transition from dynamic conditions (before fracture closure) to static conditions (after fracture closure). This innovative technique is rigorously validated through simulations, flow regime modeling, and real field cases. Publicly accessible data from diagnostic fracture injection tests conducted with the Step-Rate Injection Method for Fracture In-Situ Properties tool (SIMFIP) are utilized to validate this novel approach. The results demonstrate the accuracy of CWT-based closure detection, its alignment with deformation measurements, and its ability to capture intricate closure events, including pre-existing natural fractures. The Continuous Wavelet Transform introduces a novel perspective for understanding dynamic fracture propagation modes and estimating microseismic events cloud. This groundbreaking method employs CWT for treatment pressure analysis, creating a normalized CWT scalogram that provides a unique representation of each fracture propagation mode during hydraulic fracturing. It offers the potential for real-time detection of fracture modes, supporting on-the-fly decision-making to optimize hydraulic fracture treatments. The technique is meticulously calibrated using fracture simulations and real field data. Furthermore, comparisons with micro-seismic events recorded by the Marcellus Shale Energy and Environment Laboratory (MSEEL) further validate the technique's precision. Leveraging a deep learning framework that utilizes CWT to transform hydraulic fracture treatment pressure

into a dimensionless representation (normalized CWT scalogram), this approach facilitates the detection of all treatment pressure changes. This, in turn, enables the training of a deep learning model for precise estimation of micro-seismic events, providing invaluable insights for hydraulic fracture operations in the Marcellus shale formation. This can be extended to estimate the cloud of microseismic in different formations.

Biography

Mohamed Adel Gabry is a senior petroleum engineer (WS) with a decade of working experience with Khalda-Apache in Egypt. His experience in acid stimulation and hydraulic fracturing operations in conventional and unconventional reservoirs. He holds a Bachelor's degree in petroleum engineering from Suez University in 2010 and received a Master's degree in 2020. He worked as a subsurface petroleum engineer between 2011 and 2021. Then, he moved to The University of Houston to get his Ph.D. degree where he worked on the applications of Wavelet Transform in Oilfields. Mohamed published multiple papers with the SPE, OTC, and ARMA.