

Hydraulic Fracture Diagnostics: Understanding Fracture Geometry and Well Performance

1.6 CEUs (Continuing Education Units) awarded for this 2-day course.

Instructors

Craig Cipolla, Dr. Norman Warpinski, Dr. Michael Mayerhofer, Dr. Shawn Maxwell - Pinnacle Technologies, Inc.

This class focuses on two important aspects of hydraulic fracturing; understanding the created fracture geometry and evaluating the “effectiveness” of the stimulation. It is essential to understand both fracture growth and fracture performance and too many times we de-couple these two issues, resulting in an inability to significantly improve stimulation treatments. Recent advances in hydraulic fracture mapping technologies have provided important insights into the growth of hydraulic fractures that were previously not possible and we continue to improve our “tool box” of analytical and numerical models to evaluate hydraulic fracture performance. Properly coupling fracture mapping technologies with our fracture performance models can provide a much better understanding of hydraulic fracture performance. The class is divided into two 1-day sessions. The sessions are relatively independent and students can attend only one of the two days if they would like to focus on a specific topic.

The first day focuses on “indirect” methods of evaluating the geometry and performance of hydraulic fractures. This includes fracture modeling, analytical rate transient analyses, numerical reservoir simulation, and pressure transient testing. The basic theory, strengths, weakness, and example applications of these methods will be discussed in the class. These indirect methods provide our only means, so far, to estimate the “effectiveness” of hydraulic fracture treatments. Interpreting the results properly and coupling the results with direct measurements of hydraulic fracture growth will be detailed at the end of day one.

The second day of the class will focus on direct measurements of hydraulic fracture geometry using microseismic and tiltmeter mapping. Day two will include an overview of the theory, application, and field operations of microseismic and tiltmeter technology. In addition, processing and analysis of microseismic and tiltmeter data will be detailed and the strengths and weakness of each technology will be outlined. Numerous field examples and case histories will be used to illustrate the application of microseismic and tiltmeter technology, data processing and analysis issues, and the integration of fracture mapping measurements with fracture models and well performance software.

About the Instructors

Craig Cipolla is Vice President Engineering Services for Pinnacle Technologies. Mr. Cipolla has over 20 years experience focused on hydraulic fracturing. Craig directs Pinnacle’s engineering services group, providing technical support to both fracture mapping and consulting projects. Craig’s worldwide experience includes work in the US, Canada, Mexico, South East Asia, North Sea, West Africa, Australia, Russia, Saudi Arabia, and the People’s Republic of China. Prior to joining Pinnacle in 1996, Craig worked for Union Pacific Resources, where his responsibilities included integrated field studies, economic evaluation and acquisition of oil and gas properties, fracturing technology, and engineering support of exploration and infill drilling programs.

Since joining Pinnacle in 1996, Mr. Cipolla has worked extensively applying state-of-the-art fracture technology worldwide, including the application of tiltmeter and microseismic fracture mapping to directly measure fracture geometry and the integration of well testing, reservoir simulation, and fracture modeling to evaluate & optimize hydraulic fracture treatments and field development. He served on the SPE Well Stimulation committee from 2002-2005 and was a member of the SPE Completions committee from 1994-1997. He also served as the technical advisor for the JPT Well Stimulation feature from 2000-2003. Mr. Cipolla was a member of the 1992 SPE *Gas Reservoir Engineering Forum committee* and the 1998 SPE *Hydraulic Fracture Diagnostics Methods Forum committee*. Mr. Cipolla was also an SPE Distinguished Lecturer on Hydraulic Fracturing in 2005-2006. Craig has authored over three dozen technical papers and conducted numerous presentations in conjunction with the Society of Petroleum Engineers, Gas Research Institute, Department of Energy, and other petroleum industry organizations. He holds a BS Degree in Engineering and a BA Degree in Chemistry from the University of Nevada and a MS in Petroleum Engineering from the University of Houston.

Dr. Norman Warpinski is Pinnacle Technologies' Chief Technical Officer. Norm has worked on hydraulic fracture modeling, mapping, and analysis for nearly thirty years, mostly on research projects while he was at Sandia National Laboratories. Norm has recently joined Pinnacle as the Chief Technology Officer, in charge of developing new tools and analyses for fracture mapping, reservoir monitoring, fracture design and analysis, and integrated solutions for reservoir development. Norm has experience in both microseismic and tiltmeter mapping, as well as fracture modeling and has been involved in large scale field experiments from both the hardware and software sides. He has also worked on formation evaluation, geomechanics, geothermal development, and carbon sequestration issues.

Norm has published over 100 technical papers, articles, and reports and was a contributing author for the SPE Monograph Volume 12 – Recent Advances in Hydraulic Fracturing. His SPE service includes: Review chairman for the Journal of Petroleum Technology, 1990 – 1993, Program committee: 1991 & 1993 Low Permeability Symposiums, Organizing committee: 1993 Hydraulic Fracturing Forum, Organizing committee: 1998 Hydraulic Fracture Diagnostics Forum, Distinguished Lecturer: 1998 – 1999, R&D Committee Member: 2002 – 2005. Norm holds a BS degree in Mechanical Engineering from the Illinois Institute of Technology and MS and PhD degrees in Mechanical Engineering from the from the University of Illinois.

Dr. Michael Mayerhofer is the applied diagnostics engineering manager at Pinnacle Technologies in Houston. His responsibilities include the application of tiltmeter and microseismic hydraulic fracture mapping results for optimizing fracture completion, well placement and infill drilling strategies, the design and evaluation of hydraulic fracturing treatments, reservoir engineering, and integrated field studies. His fifteen-year involvement with hydraulic fracturing and reservoir engineering includes fundamental research and real field applications in various global producing areas and has resulted in over 25 technical papers and journal articles. Prior to joining Pinnacle Technologies in 1997, he worked for Union Pacific Resources in Ft. Worth. He has a Doctorate in Petroleum Engineering from Mining University Leoben in Austria. He was a member of the SPE Well Completions Committee from 1998 to 2001 and he currently serves on the JPT Editorial Committee.

Dr. Shawn Maxwell is Pinnacle Technologies' Chief Geophysicist. Dr. Maxwell is responsible for technical direction of Pinnacle's microseismic monitoring services for hydraulic fracture diagnostics and reservoir monitoring. He has over 20 years experience in a broad range of microseismic monitoring applications, including mapping hydraulic fractures, fracture networks, steam floods, gas floods, water floods, casing failures, reservoir compaction, gas storage and sequestration, excavation damage around underground tunnels, and mining induced seismicity and rockbursts. Dr. Maxwell has been active in projects throughout North America, Europe, Africa and the Middle East, and his expertise includes velocity tomography of active and passive seismicity, seismic raytracing, synthetic seismograms, source characterization, data acquisition, processing and interpretation. Prior to joining Pinnacle, Dr. Maxwell spearheaded ESG's entry into the oil and gas industry, after serving as a Lecturer in Applied Seismology at Keele University, where he supervised three PhD students and eight MS students. Shawn has authored numerous publications in journals and professional abstracts.