

# The GRI Staged Field Experiment

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**Summary.** The Gas Research Inst.'s (GRI's) Tight Gas Sands Program has been involved with research on low-permeability formations during the past 4 years. The main focus of the research has been to improve the general understanding of producing tight reservoirs, while a specific focus has been to advance the technology involving hydraulic-fracture geometry. The unique aspect of this research is that the laboratories have been actual gas wells completed in the Travis Peak formation in east Texas.

To extend the development of technology fully, GRI has planned four staged field experiments (SFE's) from 1986 through 1989. The SFE program provides the opportunity to collect a wealth of data that cannot be obtained from normal cooperative research wells. The purpose of this paper is to summarize all the tests and data collected on the first SFE and to present the available results from the analyses of these data.

## Introduction

Research directed at reducing the cost and improving the recovery of gas produced from low-permeability reservoirs is currently being sponsored. Because the most viable method of improving recovery in tight formations is hydraulic fracturing, part of the research is aimed at better understanding of the processes that control fracture growth. If the petroleum industry can substantially improve its ability to predict and to control the shape of hydraulic fractures accurately, then the chances of achieving optimum propped-fracture lengths are increased. The end result will be an improved economic incentive for developing tight gas reservoirs.

To understand the hydraulic-fracturing process better, it is first necessary to improve our understanding of both the reservoirs being fracture treated and the formations surrounding the main productive interval. To achieve this goal, a comprehensive program was initiated to perform geologic, coring, logging, well testing, fracture-treatment monitoring, and fracture-diagnostic studies on selected cooperative research wells in the Travis Peak formation of the East Texas basin.

One technical approach is to use the necessary electronic equipment and computers in the field so that the GRI contractors may actually analyze the fracture-treatment data in real time. Once this system is perfected, we should be able to predict fracture shape and extent. If this can be accomplished successfully, we will then attempt to control fracture growth by controlling the fracture-fluid viscosity or the injection rate.

The success of the program hinges on the cooperation of operating companies. Through their participation, GRI contractors are allowed to collect the data necessary for a complete formation and fracture evaluation from actual gas wells referred to as cooperative wells. With these data, we feel that substantial progress can be made toward the development of tight gas through better stimulation technology.

Table 1 lists all GRI contractors, service companies, and producing companies that cooperated with GRI in the field data collection effort. Table 2 summarizes the data collected during the first 3 years of this research program.

The cooperative research wells are just the first step in the overall plan to characterize fully the formation and hydraulic fracture in three dimensions. The next phase of the plan is to pull all GRI contractors together on strategic wells to use all possible means of improving the understanding of tight gas reservoirs. This phase is called the staged field experiments (SFE's).

## Goals of the SFE's

Four SFE's are planned from 1986 through 1989. An SFE will allow the research contractors to collect the same basic data that have been available from most of the cooperative wells. Additional data,

however, that have not been collected on cooperative wells because of either high cost or high risk to the operator will also be obtained during the SFE.

The specific goals of each SFE are listed below.

### SFE 1: 1986-87.

1. To bring together all tight gas sand contractors to study a common formation and wellbore.
2. To drill, complete, and stimulate a highly instrumented well to collect and analyze one of the most comprehensive data sets ever obtained in the industry.
3. To implement data-collection methods that will be structured to benefit the research contractors working on fracture-diagnostic techniques and fracture-modeling efforts.
4. Information obtained during the SFE will be presented to industry in an integrated form to facilitate technology transfer. The various analyses will not be linked and may not necessarily be consistent between any two of the contractors.

### SFE 2: 1987-88.

1. A three-dimensional (3D) fracture-design and -evaluation model will be able to analyze the data in real time and to offer suggestions concerning changes that should be considered to improve the treatment results.
2. Fracture-diagnostic experiments will be evaluated to focus future research efforts on the most promising of the techniques. All fracture-diagnostic methods will be separate from the fracture-modeling efforts.
3. Field-measuring and -monitoring systems of the GRI Mobile Testing and Control Facility will be superior to all other field systems in terms of versatility, accuracy, and reliability.
4. Experiments will focus mainly on the determination of fracture-height and fracture-length measurements and/or calculations of these properties.

### SFE 3: 1988-89.

1. Fracture-modeling systems will be computing fracture shape with precision.
2. Fracture-diagnostic systems will be functional and provide input to the fracture models in real time.

### SFE 4: 1989-90.

1. Move to a new location and prove that the technology developed can be transferred to a different environment.

## Site Selection for SFE 1

Rigorous selection criteria set up for the first SFE included (1) the presence of direct offset wells, (2) blanket-type sand deposition over a fairly wide area, (3) the presence of discrete individual sand mem-

# Staged Field Experiment No 3

**Ching H. Yew, Xiaowei Weng**



### **Staged Field Experiment No 3:**

**Staged Field Experiment** ,1991      Improved Reservoir Models and Production Forecasting Techniques for Multi-Stage Fractured Hydrocarbon Wells Ruud Weijermars,Wei Yu,Aadi Khanal,2019-12-12 The massive increase in energy demand and the related rapid development of unconventional reservoirs has opened up exciting new energy supply opportunities along with new seemingly intractable engineering and research challenges The energy industry has primarily depended on a heuristic approach rather than a systematic approach to optimize and tackle the various challenges when developing new and improving the performance of existing unconventional reservoirs Industry needs accurate estimations of well production performance and of the cumulative estimated ultimate reserves accounting for uncertainty This Special Issue presents 10 original and high quality research articles related to the modeling of unconventional reservoirs which showcase advanced methods for fractured reservoir simulation and improved production forecasting techniques      **Mechanics of Hydraulic Fracturing** Ching H. Yew,Xiaowei Weng,2014-09-25 Revised to include current components considered for today s unconventional and multi fracture grids Mechanics of Hydraulic Fracturing Second Edition explains one of the most important features for fracture design the ability to predict the geometry and characteristics of the hydraulically induced fracture With two thirds of the world s oil and natural gas reserves committed to unconventional resources hydraulic fracturing is the best proven well stimulation method to extract these resources from their more remote and complex reservoirs However few hydraulic fracture models can properly simulate more complex fractures Engineers and well designers must understand the underlying mechanics of how fractures are modeled in order to correctly predict and forecast a more advanced fracture network Updated to accommodate today s fracturing jobs Mechanics of Hydraulic Fracturing Second Edition enables the engineer to Understand complex fracture networks to maximize completion strategies Recognize and compute stress shadow which can drastically affect fracture network patterns Optimize completions by properly modeling and more accurately predicting for today s hydraulic fracturing completions Discusses the underlying mechanics of creating a fracture from the wellbore Enhanced to include newer modeling components such as stress shadow and interaction of hydraulic fracture with a natural fracture which aids in more complex fracture networks Updated experimental studies that apply to today s unconventional fracturing cases      **Energy Research Abstracts** ,1993      **Rock Fractures and Fluid Flow** National Research Council,Division on Earth and Life Studies,Commission on Geosciences, Environment and Resources,Committee on Fracture Characterization and Fluid Flow,1996-09-27 Scientific understanding of fluid flow in rock fractures a process underlying contemporary earth science problems from the search for petroleum to the controversy over nuclear waste storage has grown significantly in the past 20 years This volume presents a comprehensive report on the state of the field with an interdisciplinary viewpoint case studies of fracture sites illustrations conclusions and research recommendations The book addresses these questions How can fractures that are significant hydraulic conductors be

identified located and characterized How do flow and transport occur in fracture systems How can changes in fracture systems be predicted and controlled Among other topics the committee provides a geomechanical understanding of fracture formation reviews methods for detecting subsurface fractures and looks at the use of hydraulic and tracer tests to investigate fluid flow The volume examines the state of conceptual and mathematical modeling and it provides a useful framework for understanding the complexity of fracture changes that occur during fluid pumping and other engineering practices With a practical and multidisciplinary outlook this volume will be welcomed by geologists petroleum geologists geoengineers geophysicists hydrologists researchers educators and students in these fields and public officials involved in geological projects

Unconventional Reservoir Geomechanics Mark D. Zoback, Arjun H. Kohli, 2019-05-16 Since the beginning of the US shale gas revolution in 2005 the development of unconventional oil and gas resources has gathered tremendous pace around the world This book provides a comprehensive overview of the key geologic geophysical and engineering principles that govern the development of unconventional reservoirs The book begins with a detailed characterization of unconventional reservoir rocks their composition and microstructure mechanical properties and the processes controlling fault slip and fluid flow A discussion of geomechanical principles follows including the state of stress pore pressure and the importance of fractures and faults After reviewing the fundamentals of horizontal drilling multi stage hydraulic fracturing and stimulation of slip on pre existing faults the key factors impacting hydrocarbon production are explored The final chapters cover environmental impacts and how to mitigate hazards associated with induced seismicity This text provides an essential overview for students researchers and industry professionals interested in unconventional reservoirs

**Unconventional Hydrocarbon Resources** Reza Barati, Mustafa M. Alhubail, 2020-12-03 A comprehensive textbook presenting techniques for the analysis and characterization of shale plays Significant reserves of hydrocarbons cannot be extracted using conventional methods Improvements in techniques such as horizontal drilling and hydraulic fracturing have increased access to unconventional hydrocarbon resources ushering in the shale boom and disrupting the energy sector Unconventional Hydrocarbon Resources Techniques for Reservoir Engineering Analysis covers the geochemistry petrophysics geomechanics and economics of unconventional shale oil plays The text uses a step by step approach to demonstrate industry standard workflows for calculating resource volume and optimizing the extraction process Volume highlights include Methods for rock and fluid characterization of unconventional shale plays A workflow for analyzing wells with stimulated reservoir volume regions An unconventional approach to understanding of fluid flow through porous media A comprehensive summary of discoveries of massive shale resources worldwide Data from Eagle Ford Woodford Wolfcamp and The Bakken shale plays Examples homework assignments projects and access to supplementary online resources Hands on teaching materials for use in petroleum engineering software applications The American Geophysical Union promotes discovery in Earth and space science for the benefit of humanity Its publications disseminate scientific knowledge and provide resources for researchers

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*Selected Water Resources Abstracts*, 1990      **Annual Report of the Bureau of Sugar Experiment Stations** Queensland. Bureau of Sugar Experiment Stations, 1928      **Greenhouse Gas Emissions and Mitigation: Microbes, Mechanisms and Modeling** Baoli Zhu, Yong Li, Zengmin Chen, Hangwei Hu, Andrian-Stefan Andrei, 2024-05-29

Currently the global average temperature is projected to increase by 0.2 C per decade due to past and ongoing greenhouse gas (GHG) emissions To limit global warming to 1.5 C above pre industrial levels not only does carbon dioxide (CO<sub>2</sub>) emission need to reach net zero around 2050 but the emissions of other GHGs also have to reduce substantially Nitrous oxide (N<sub>2</sub>O) and methane (CH<sub>4</sub>) are very important GHGs and their global warming potentials are 300 and 25 times that of CO<sub>2</sub> over a 100 year time scale Since pre industrial times atmospheric N<sub>2</sub>O concentrations have increased by more than 20% and CH<sub>4</sub> concentrations have nearly tripled to the current 1900 ppb Studies have suggested that the ongoing increase of atmospheric N<sub>2</sub>O and CH<sub>4</sub> emissions is mostly attributed to microbial activities

*Analytics, Policy, and Governance* Jennifer Bachner, Benjamin Ginsberg, Kathryn Wagner Hill, 2017-01-01

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**Agriculture, rural development, and related agencies appropriations for 1986** United States. Congress. House. Committee on Appropriations. Subcommittee on Agriculture, Rural Development, and Related Agencies, 1985      Seed Wheat Charles Embree Thorne, J. Fremont Hickman, Ohio Agricultural Experiment Station, 1908

## Whispering the Secrets of Language: An Psychological Journey through **Staged Field Experiment No 3**

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