

ProTechnology

COMPLETION DIAGNOSTICS NEWS FROM PROTECHNICS

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THE BAKKEN IS BACK!

INDEPENDENTS ARMED WITH NEW TECHNOLOGIES TAKE THE LEAD AGAIN

Spend a few days in the Williston Basin and you will quickly come to know that the Bakken is back.

From the sweet spot located in Montana's Richland county and extending north and east into North Dakota, this unconventional oil play is one of the hottest in the upper Rockies. As with most unconventional plays today, the Bakken is being exploited predominantly by mid-to-large independents applying new technologies, spurred by high oil prices. Gauged by the high demand for rigs in the area, the future looks bright.

The key to recent Bakken success is the application of improved horizontal drilling and massive hydraulic fracturing technologies. New directional control and the ability to drill multiple laterals have made the economics of this play viable. Even though the Bakken is productive without fracturing, experience has shown that effectively fracturing these laterals significantly improves the production rate and ultimate recovery.

Completion diagnostics provided by ProTechnics are being employed by almost all area operators to provide the only direct measurements able to determine the effectiveness of the fracture treatment. Evolutions in well completions—such as drilling longitudinal or transverse to the maximum stress, whether to cement the

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—GARY DITTMAR, LYCO PRODUCTION MANAGER

liner or not, the use of limited-entry perforating and other issues—are being validated through the use of completion diagnostics.

From the early development of the current Bakken play, ProTechnics completion diagnostic services and SpectraScan imaging have played a key role. Many stimulation decisions have been evaluated based on measurements of actual fracture placement and the effectiveness of diverting stages.

One of the area's most successful operators, Lyco Energy Corporation, has successfully teamed with Halliburton Digital Consulting Solutions to develop a completion strategy tailored to the Bakken.

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COMPLETION DIAGNOSTICS TECHNOLOGY HAS COME OF AGE

Over decades of application, completion diagnostics have been a source of insight and success for many of the industry's most difficult completions. In today's reservoirs, where the term "unconventional" has become commonplace, the technology has come of age. From limited application and usage, completion diagnostics has matured into a diverse and routinely called upon technology.

High oil and gas prices, and shortages in completion-related products and services, personnel and rigs have industry professionals demanding ever-more successful completions. The technical and economic challenges of these modern assets make understanding well and completion performance critical to success. A good well increasingly depends on good science.

Completion science has evolved in many forms as the industry has shifted its portfolio from conventional to unconventional prospects. This engineering innovation, driven by the steadily increasing need to understand and address the complex challenges posed by these reservoirs, has been impressive.

Low-polymer slickwater treatments, high-temperature polymers and other exotic fluid and breaker systems now allow careful matching of completion materials to formation characteristics. Proppants of various densities and strengths improve transport and conductivity in the most rigorous applications. These components are applied using highly-automated systems that allow implementation of complex fracture treatment designs.

Equally impressive has been the innovation and development of completion diagnostic technologies capable of providing the only direct measurements of completion effectiveness. Isotope and chemical tracers uniquely identify completion placement and fluid cleanup dynamics. Coupled with an impressive array of memory-based imaging technologies including spectral gamma ray, early production logs and gamma density pack evaluation logs, fracture treatments are being understood like never before.

The direct measurements provided by these diagnostic systems are critical to effective calibration of frac models. Designs created

using new-generation, true 3D frac models and calibrated using completion diagnostics have caused a significant change in the way we think about the reservoir and its response to a fracture treatment.

New fracture designs and near-wellbore diagnostics strongly suggest that fracture geometries are not easily modeled using the "simplistic" theories of the recent past. Successful engineers have recognized that advanced modeling and direct measurements obtained through completion diagnostics play a critical role in their ability to understand and modify the treatment.

Completion diagnostics are being successfully applied in most of today's unconventional and high profile plays.

Oil Shale (PTNL Spring 2006/April) – When independents went back to develop the Middle Bakken in northern Montana (see lead article), they applied new technologies such as horizontal completions and large volume water fracs.

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One of the early challenges was to develop a completion procedure that optimized placement of fracture stages across the entire lateral. Completion diagnostic tracers and coiled tubing-deployed spectral imaging provide the necessary after-frac information to evaluate different techniques.

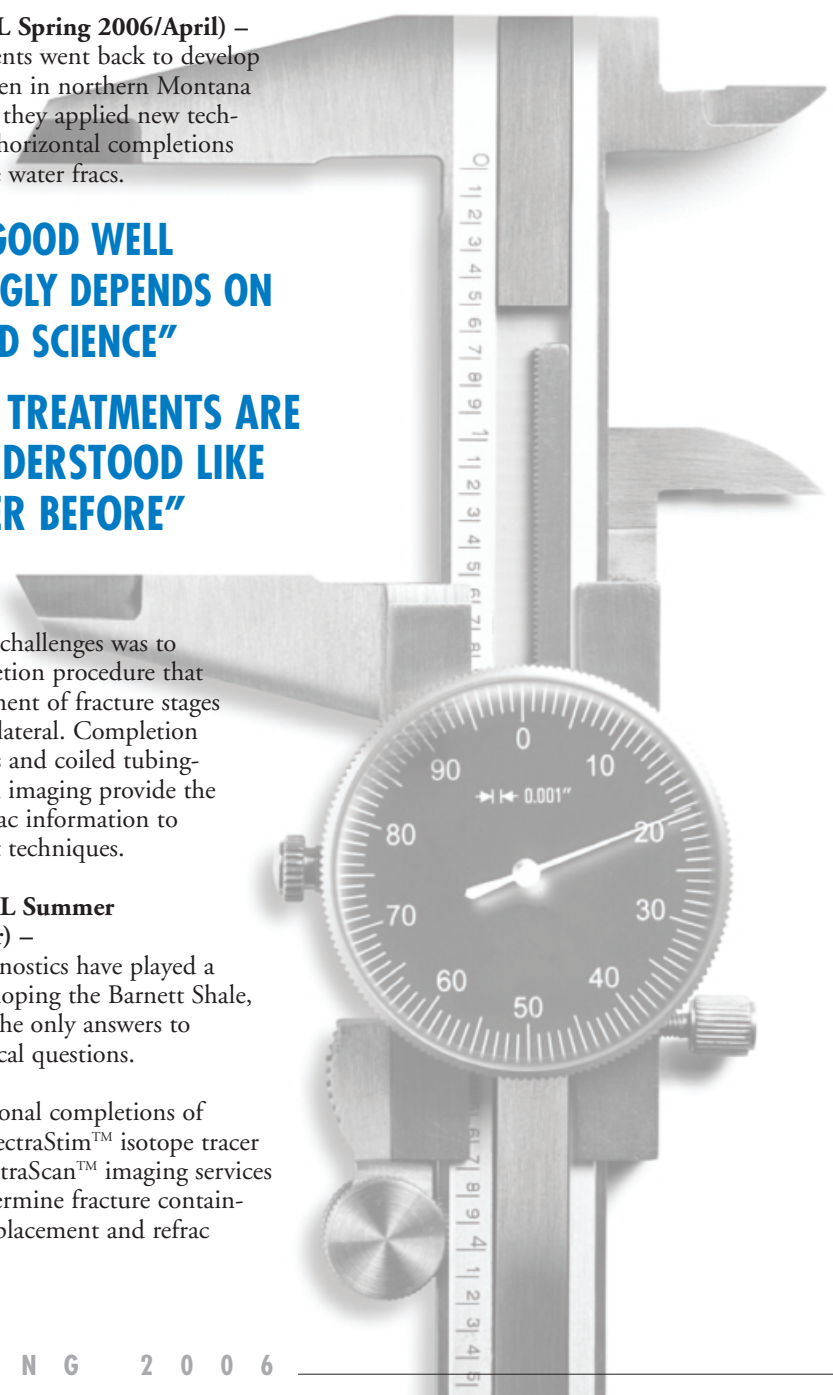
Gas Shale (PTNL Summer 2005/September) – Completion diagnostics have played a vital role in developing the Barnett Shale, often providing the only answers to many technological questions.

In early conventional completions of vertical wells, SpectraStim™ isotope tracer services and SpectraScan™ imaging services were used to determine fracture containment, proppant placement and refrac effectiveness.

In addition to SpectraStim services, today's horizontal completions include SpectraChem chemical tracing services. These services help engineers understand the dynamics of treatment fluid cleanup, optimize stimulation performance and improve future well placement through two primary applications:

- Fluid recovery profiles to characterize the effectiveness of the horizontal section flow-back
- Positive evidence of communication between treatment well and offset producers

Scheduled samples of the flowback fluid are collected and then analyzed for the specific chemicals using gas chromatography and mass spectrometry in the parts per



billion. The results are normalized and plotted to develop a profile of individual and collective tracer flowback concentrations vs. elapsed flowback times or cumulative flow back volumes.

Deepwater GOM (PTNL Spring 2005/April) – We used to describe 1,000 ft of water as “deep water.” Now we are talking about 10,000 ft water depths, along with smart wells, double-stack and triple-stack completions, deep HP/HT and even ultra HP/HT.

As deepwater challenges have grown, the need for and the application of completion diagnostics has also increased. Today, combination SpectraScan and Packscan tracer and pack density logs are routinely acquired from tool placement inside the washpipe. This practical and economical means of gaining some of the only available completion diagnostics has become common place for deepwater pioneers. Newly introduced chemical tracers are just now starting to find their own niche in these extreme environments.

Coalbed Methane (PTNL Spring 2004/May) – In the San Juan Basin of New Mexico, completion diagnostics are helping operators understand the effectiveness of their coal bed methane completions. In the Fruitland Coal, for example, operators are faced with completing as many as five coal stringers in a single treatment (including two low-pressured, highly fractured zones). SpectraStim isotope tracer applications provided the critical measurements that in some cases revealed zonal stimulation effectiveness. By-passed pay was identified.

Tight Gas Sands (PTNL Winter 2004/Dec) – In the Bossier Sands of Robertson County, Texas, chemical frac tracers in conjunction with post-frac well performance monitoring, have been used to assess cleanup efficiency and production resulting from a strong oxidizing breaker in the slick-water prepad of a hybrid water frac treatment. To aid in fracturing fluid design optimization, chemical frac tracers were used to study the cleanup performance of two traditional crosslink fluid types using borate and zirconate crosslinkers in a hybrid waterfrac design.

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PLAN NOW FOR 2006 GOHFER COURSES

Registration for the 2006 GOHFER Advanced Hydraulic Fracturing Design Theory & Model Introduction course is underway. The fracturing course provides an in-depth understanding of hydraulic fracturing using the GOHFER planar 3D fracture simulator.

The course is taught by Dr. Bob Barree, author of the GOHFER simulator software, and Dr. Mike Conway, president of Stim-Lab. Their classes provide a very knowledgeable and interesting study of GOHFER-implemented state-of-the-art fracturing concepts from theory to design strategies. Hands-on training focuses on individual stimulation projects.

Current users or engineers looking to expand their GOHFER skill will benefit from this course. Courses will be held at the following locations and dates:

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|----------------------------|-----------------|
| • Denver, Colorado | June 12-14 |
| • Calgary, Alberta, Canada | September 11-13 |
| • Houston, Texas | October 23-25 |

In addition to scheduled courses, in-house GOHFER Fracturing Courses can also be arranged.

TO VIEW COURSE OUTLINES AND TO OBTAIN A REGISTRATION FORM, VISIT WWW.GOHFER.COM OR CONTACT YOUR LOCAL PROTECHNICS REPRESENTATIVE. FOR INFORMATION ABOUT GOHFER 3-D FRACTURE SIMULATION SOFTWARE, CONTACT KEVIN SVATEK AT 713.328.2304 OR KEVIN.SVATEK@CORELAB.COM



GROWING TO MEET DEMAND

PROMOTIONS AND MOVES

Todd Sasche – Promoted to District Manager in Kilgore, Texas

Chad Richardson – Named Production Line Specialist for InvasionProfiler

Brandon Watson – Transferred to Grand Junction, CO

Luke Handy – Has moved to imaging service engineer, Lafayette, LA

NEW ADDITIONS

ProTechnics continues to increase service capabilities and add to its technology prowess.

Welcome aboard:

SALES REPRESENTATIVE

Summer Sanford – Houston, TX

HS&E SUPERVISOR ENVIRONMENTAL COMPLIANCE

Andrew Allain – Houston, TX

FIELD SERVICE REPRESENTATIVES

Bob Crabtree – Sidney, MT

Steve Beck – Oklahoma City, OK

David Tobar – Midland, TX

Nephi Boyer – Rock Springs, WY

Mark Rogers – Kilgore, TX

IMAGING SERVICE ENGINEERS

Tucker Brooks – Farmington, NM

INTERNATIONAL FIELD SERVICE REPRESENTATIVE

Brandon Patterson

Congratulations and Good Luck In Your New Positions!

EXPANDING CAPABILITIES

Our international operations continue to expand with major projects in:

- Africa
 - Cabinda
 - Equatorial Guinea
 - Nigeria
- Asia
 - China
- Middle East
 - Oman

EXPERT'S CORNER

Interview with Tom Lantz, Halliburton DCS - Asset Management

Lessons Learned: Developing the Bakken in Northern Montana

ProTechnology is pleased to present an interview with Tom Lantz, western asset manager with Halliburton Digital and Consulting Solutions, in our continuing series of interviews with top industry experts on important industry topics. This interview features the Bakken play in northern Montana.

After graduating from the University of Southern California with a BS in Chemical Engineering, Tom attended Colorado State University to do graduate studies in mechanical engineering.

His early work with ARCO and Phillips Petroleum Company provided him with extensive and varied experiences in comple-



tion and reservoir engineering in the Rockies, California, North Sea and Gulf of Mexico. Tom has spent the last 5 years as a technical expert for Halliburton Energy Services in their Denver office. He is currently the manager for the Lyco Energy and Halliburton DCS joint partnership to develop the significant reserves in the Bakken play. His experience in this successful venture has made him a recognized expert and author on the Bakken development.

In this interview, Tom shares lessons learned from the past two years and over 100 well completions in the Bakken play. The entire interview can be downloaded from the ProTechnics website at www.corelab.com/protechnics.

Interview topics include:

- Producing mechanism of the Bakken
- Horizontal well completion strategies
- Fracturing techniques
- Flowback strategies
- Well spacing and lateral length

Notable quotes from the interview

"Current development efforts view the Middle Bakken member as a low permeability, matrix dominated reservoir..."

"...stimulated lateral length is the key factor in maximizing productivity and recovery."

"...spectral logs have been used to prioritize candidates for re-stimulation"

"We are strong believers that these clean-out operations are useful..."

Note from the Editor The Expert's Corner is a continuing feature of ProTechnology newsletter. Our objective is to bring you interviews and discussions with industry-recognized experts that examine the latest and most current knowledge and opinions on the subject of stimulation. Because of the length of most interviews, interview highlights are presented in this newsletter, with the entire interview published on the ProTechnics website.

TO SHARE YOUR THOUGHTS, IDEAS AND SUGGESTIONS ABOUT EXPERT'S CORNER, PLEASE CONTACT WADE HUTCHINSON AT WADE.HUTCHINSON@CORELAB.COM

THE BAKKEN IS BACK!

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During a recent conversation, Gary Dittmar, Lyco's production manager, commented that, "Completion diagnostics provided by ProTechnics empowered our engineering team with the only direct measurements to determine the effective placement of the fracture treatment. This knowledge was critical to our completion evolution."

SpectraChem tracers, which are being used extensively in the Barnett Shale play in north Texas, are just now starting to be considered for the Bakken. (See PTNL Summer 2005 September)

The patented chemical tracers provide an economic, effective means to determine lateral cleanup. Typically used in conjunction with SpectraStim isotope tracers, a unique chemical tracer is injected into each different stage. Subsequent laboratory

chemical analysis of the flowback fluids can qualitatively and quantitatively determine if all stages are contributing to flowback and to what degree they are cleaning up. Offset well interference can also be analyzed through the use of SpectraChem tracers.

New technologies teamed up with completion diagnostics have brought new life back to the Bakken development.

FOR MORE INFORMATION, PLEASE CONTACT BILL YURKOSKI AT BILL.YURKOSKI@CORELAB.COM

COMING NEXT ISSUE

ANOTHER MEASURED SOLUTION FROM PROTECHNICS

**Quantify mud
filtrate invasion
in cores**

**Quantify mud
filtrate invasion
in formation
fluid samples**

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