

ProTechnics

Expert's Corner

BAKKEN DISCUSSION

LESSONS LEARNED: DEVELOPING THE BAKKEN IN NORTHERN MONTANA

Interview with Tom Lantz, Halliburton DCS – Asset Management

Interviewed by
Wade Hutchinson



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 completion 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 in northern Montana. His experience is this successful venture has made him a recognized expert and author on the Bakken development.

Q: ProTechnics

The Bakken formation was originally developed in the 1980s. Since that time, many different drilling and completion strategies have been attempted. Would you briefly describe for our readers the evolution of the Bakken development?

A: Tom Lantz

The earlier Bakken play in the 1980s was focused on horizontal drilling in the upper shale member of the Bakken formation. Like many horizontal developments at the time, this effort targeted a fractured reservoir. The well was designed to intercept fracture systems within the zone and produce fractures with a natural, unstimulated completion. The current development efforts view the Middle Bakken member as a low permeability, matrix-dominated reservoir incorporating stimulated laterals to enhance well productivity.

Q: ProTechnics

While the most recent activity has been in the Middle Bakken, early production was attempted for the Upper Bakken Shale zone. Would you describe the geological and petrophysical aspects of the Middle Bakken and comment on its production mechanism?

A: Lantz

The Middle Bakken zone on the western margins of the Williston Basin (Richland County, MT) is predominately a silty, dolomitic reservoir that fines downward and is bounded by the Upper and Lower Bakken shales. The main pay zone ranges

from 8 to 15 ft in net thickness with porosity of 8 to 12% and water saturation averaging about 20%. Measured permeability values range from 0.005 to 0.5 md. There is some natural fracturing, although it acts to enhance permeability rather than acting as a classic dual porosity system. The lithology of the Middle Bakken zone changes as it moves north and east into the basin, where it typically becomes more silty and sandy with an associated decrease in porosity and higher water saturations.

Q: ProTechnics

It seems that most unconventional plays being exploited today (i.e. coal bed methane, gas shales, and oil shales) have found success with horizontal drilling and well completions. What makes horizontal completions successful in these kinds of reservoirs?

A: Tom Lantz

The benefit of horizontal completions in these types of reservoirs boils down to the ability to cost-effectively increase wellbore exposure to the reservoir. A good example is the analysis of the Middle Bakken development which consistently shows that wells with the maximum stimulated lateral length yield the best performance. The increased reservoir exposure improves the probability of success by helping to overcome the reservoir heterogeneity, whether it be due to variability of matrix

permeability or just contacting more natural fractures.

Q: ProTechnics

Two strategies when deciding to use horizontal completions have to be addressed early in an exploitation program. These strategies are first whether to drill longitudinal or transverse to the maximum principal stress and, second, whether to complete open hole or cement a liner. How were these major decisions reached and what is the current approach to drilling these horizontal wells?

A: Tom Lantz

We developed the initial well plan using the results of both reservoir and fracture simulations. A mechanistic reservoir simulation study using a history-matched model from some vertical completions indicated there was minimal difference between the well productivities and ultimate recoveries for wells oriented for either longitudinal or transverse fractures.

Using this premise, the wells were oriented to foster longitudinal hydraulic fractures. That was viewed to be a more reliable, cost-effective way to stimulate the entire lateral length. Likewise, we decided to use a cemented liner with a limited-entry perforation design to try and control entry points along the lateral, thus improving our chances of stimulating the entire length. That design was based on conventional thinking that the heel section would tend to take a disproportionate share of the frac and leave the toe section unstimulated.

After observing a surprising trend of the heel section not being treated effectively, the current completion design evolved. It uses uncemented liners in the lateral and multiple stage frac designs with positive diverter stages (ball sealers and high con-

centration sand slugs). These changes yielded more consistent coverage of the laterals and translated into a 25% average productivity improvement compared to the previous designs.

Q: ProTechnics

Unlike the Barnett Shale of north Texas, another hot unconventional play (*See PTNL Summer 2005/September*), it is generally accepted that the Bakken does not produce from secondary porosity, i.e. natural fractures. There is, however, some debate as to the effect of limited natural fractures on the overall production. Would you shed some light on this subject?

A: Tom Lantz

As you say, there are some differences of opinion about the significance of the natural fractures in the Bakken. But I don't think there is much doubt that we are dealing with a matrix storage system in which natural fractures enhance the native permeability to varying degrees across the field.

Q: ProTechnics

What are the key drivers for a successful completion in the Middle Bakken?

A: Tom Lantz

As I mentioned above, the stimulated lateral length is the key factor in maximizing productivity and recovery. Of course success always has an economic component so there are different approaches to it. Some folks are focusing more on maximizing drilled length and then trying to bring their stimulation designs up to par while others are working to ensure they effectively stimulate their entire lateral length and then extend the lengths as merited.

Q: ProTechnics

In SPE paper No. 90697, *Improved Horizontal Well Stimulations in the Bakken Formation, Williston Basin*, fracturing evolution was discussed. Completion diag-

nostics, such as isotope tracers and after-frac spectral logging, are being used extensively in the Bakken to provide a measure of completion progress. In your opinion, what role have these technologies played in developing the best-practice completion? What role do you expect completion diagnostics to play in the future?

A: Tom Lantz

The review and analysis of spectral logging results combined with production performance analysis has been the basis for all of the completion practice developments. Since there is an extremely limited amount of reservoir data collected to quantitatively assess the reservoir quality, the combination of these two techniques has allowed us to identify and remedy wells where completion effectiveness may be the cause of underperformance, as opposed to poorer reservoir quality.

In fact, the spectral logs have been used to prioritize candidates for re-stimulation and have been used with production statistics to forecast the rate improvement expected from remedial work. As far as continuing use of completion diagnostics, we expect to continue radioactive tracer applications and are looking at uses of chemical tracers and frac mapping techniques to further improve our understanding of fracture behavior and potential interference between wells as the field is down-spaced.

Q: ProTechnics

The Barnett Shale in the Fort Worth area has also seen extensive use of completion diagnostics. Operators are using isotope tracers similar to the Bakken, but are also using more and more chemical tracers to measure many other parameters. For example, offset well interference during fracturing has provided valuable information concerning interwell fracture connection. What role do you see chemical tracers playing in the Bakken as this play develops in the future?

A: Tom Lantz

We are investigating use of chemical tracers as a means of refining our best practices for completing wells in the Bakken. We also think they may help shed some light on the nature of the interwell communication that had been sporadically observed throughout the field development and guide some thinking on enhanced recovery potential in the field.

Q: ProTechnics

There seems to be more unity among the operating and consulting community concerning drilling and completion practices than strategies concerning after-frac cleanup and production. What are your opinions concerning when and how to clean up and produce a Bakken completion?

A: Tom Lantz

I believe that you may be overstating the idea that there is a consensus on drilling and completion practices. There is still a fair amount of diversity of opinion on these matters. Likewise, opinions on cleaning up and producing the completions are somewhat varied. I think most people are using pretty aggressive breaker systems to facilitate fracture clean up and most everyone tries to get the wells turned around to flow as quickly as possible after completion of the job.

There are some differences in the approach of how hard to draw down the well during the flow back. We've observed our best results with moderate flowback rates which maintains some back pressure on the well. One of the interesting observations regarding the Richland County, Montana, wells is they return to very high oil cut, usually more than 90%, within about two days with less than 10% of the load fluid recovered. People have some differences of opinion regarding the benefit of going in

and cleaning out the laterals. We are strong believers that these clean-out operations are useful, having observed significant production increases in a large number of wells with no instances of detrimental effects.

Q: ProTechnics

What are the current lateral lengths and well spacings? Where do you see these parameters going to in the future?

A: Tom Lantz

The Bakken development in the Richland County area is rapidly moving towards 320 acre equivalent spacing. This entails placing two 4000 ft single laterals in a 640-acre spacing unit or drilling two long laterals (+/- 9500 ft) or two opposed dual laterals in 1,280-acre spacing units. There are also some rather creative well designs utilizing tri-laterals to effectively increase well density in a given spacing unit—although they create problems of their own so that the jury may still be out on those.

I think most operators are trying to maximize their lateral lengths within any given lease or spacing-unit constraint. Although I think there remains some concern about how to optimally stimulate longer lateral designs, incremental economic factors tend to favor those designs.

Q: ProTechnics

Have any attempts been made to re-fracture Bakken and what are the results so far?

A: Lantz

We have seen significant improvements in rates and recoveries from returning to early completions and re-fracturing them with current designs. Most of these increases can be attributed to improved fracture coverage of the lateral sections. We observed several wells that had cumulative production of 30,000 to 50,000 bbl that produced at higher rates after the re-stimulation than they did after the initial completion.

Q: ProTechnics

ProTechnology is very grateful for your time and effort in this Expert's Corner interview. I am sure our readers have benefited greatly. In closing, can you make a few general comments as to your opinion of the extent and duration of this current play and the most promising expansion areas for the future?

A: Tom Lantz

Certainly the thrust of the Middle Bakken play is moving north and east into the deeper sections of the basin in North Dakota. Since the lithology changes from predominantly higher quality dolomitic facies to a lower quality silty/sandy facies, the reservoir does not seem to be nearly as forgiving in North Dakota area as it is in the original play area. The ultimate extent and duration of the play will hinge on how effective we are in understanding these changes and tailoring the drilling and completion designs to exploit this lower quality reservoir.

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This interview was previewed in the spring 2006 / April issue of the ProTechnology newsletter. To download a complete version of this and other interviews, as well as other information on completion diagnostics, please visit our website at www.corelab.com/protechnics