

# RESERVOIR *SOLUTIONS*

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## 13th Annual Ryder Scott Reserves Conference

Sept. 21st

Ryder Scott Conference  
– See Page 2

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# 13th Annual Ryder Scott Reserves Conference on Sept. 21<sup>st</sup>

## Experts at RS reserves conference to update industry on several fronts

Whether private or public, big or small, well-funded or not, E&P companies in the U.S. oil patch are narrowing their targets to shale properties that remain economic at sub \$50-a-barrel oil. They are also focusing on conventional reservoirs using advanced drilling-and-completion (D&C) techniques.

A current assortment of major E&P players and their stories will be on display at the 13th Annual Ryder Scott Reserves Conference in Houston this September. Please see schedule and agenda on opposite page.

Better approaches in the reserves-evaluation sector will be featured at the conference. Traditional type-curve analysis, a decades-old, time-efficient method to estimate EURs from hundreds or thousands of wells, is getting a new name and makeover.

Please see articles on type-well analysis on pages 5 and 8, as summarized from the Ryder Scott Canada Reserves Conference last May. Both of the respective speakers — **John Lee**, professor at Texas A&M University, and **Vitaliy Charkovskyy**, a senior petroleum engineer at Ryder Scott Canada — will present at the Houston conference.

Organizers anticipate a full house of almost 400 at the Hyatt Regency hotel in downtown Houston, Thursday, Sept. 21, which would make it the largest-ever single gathering of senior reserves evaluators, eclipsing last year's attendance.

### Alpine High raises spirits

Independents as well as majors are exploring and finding unconventional resources with potential production and cash flows that promise to exceed target returns. Expertise and organic growth through the drillbit will never go out of style. The Alpine High field — a confirmed discovery last year in a relatively unexplored area of the Delaware basin in the Permian — is a headline grabber. Apache Corp. initially estimated that hydrocarbons in place to be 75 Tcf of gas and 3-billion BOE in the Barnett and Woodford formations alone. *Please see Reserves Conference on page 4*

**Brandon Blossman**, managing director at Tudor, Pickering, Holt & Co. Securities Inc., at last year's conference.



### Details at a Glance

**When:** Thursday, Sept. 21, 7 a.m. to 5 p.m.

**Ethics Hour:** Starts at 4 p.m.

**Cocktail Reception:** 5 p.m. to 7 p.m.

**Where:** Hyatt Regency Hotel, Imperial Ballroom, 1200 Louisiana St., Houston, Texas 77002

Schedule of Events			
"Evaluation Challenges in a Changing World"			
Time	Speaker	Affiliation	Topic
7 a.m. – 8 a.m.			Conference Check In and Light Breakfast
8 a.m. – 8:30 a.m.	<b>Don Roesle</b> CEO	Ryder Scott Co. LP	Welcome and Introduction
8:30 a.m. – 9:15 a.m.	<b>John Lee</b> Professor	Texas A&M University	Type Well Profile Analysis - Complexities and Analytic Techniques
9:15 a.m. – 10 a.m.	<b>Vitaliy Charkovskyy</b> Sr. Petroleum Engineer	Ryder Scott Canada	Practical Type Well Profile Construction
10 a.m. – 10:30 a.m.			Break
10:30 a.m. – 11 a.m.	<b>David Porter</b> Principal	Swan Energy Inc.	TRRC Abandoned Well and Plugging Program and Regulatory Problems from Fluctuating O&G Prices
11 a.m. – 11:30 a.m.	<b>Natalie Brown</b> Reservoir Engineering Manager	Forge Energy LLC	Application of Unconventional Thinking to Redevelop a Conventional Reservoir
11:30 a.m. – 12:30 p.m.			Buffet Luncheon
12:30 p.m. – 1:15 p.m.	<b>Bob Thibault</b> Counsel	Haynes and Boone LLP	Financial Security Requirements for P&A, Decommissioning on OCS Leases: 800-Pound Gorilla is Dormant for Now
1:15 p.m. – 2 p.m.	<b>Marc Folladori</b> Senior Counsel	Haynes and Boone LLP	SEC Hot Button Topics, Issues and Comment Letters
2 p.m. – 2:15 p.m.			Break
2:15 p.m. – 3 p.m.	<b>Steve Gardner</b> Sr. Vice President	Ryder Scott Co. LP	Analysis of the Scoop and Stack Plays in Oklahoma
3 p.m. – 3:45 p.m.	<b>Kregg Olson</b> Exec. VP Corp. Reserves Engrg.	Apache Corp.	Alpine High: Overcoming Challenges to Make a Successful Play
3:45 p.m. – 4 p.m.			Break
4 p.m. – 5 p.m.	<b>Jorge Faz</b> Sr. Geological Consultant	Occidental Petroleum Corp.	Ethics of Reserves Evaluations
5 p.m. – 7 p.m.			Cocktail Reception



# 13th Annual Ryder Scott Conference

## Reserves Conference – Cont. from page 2

Despite great promise, the unconventional play comes with challenges on several fronts. To update Apache's progress, **Kregg Olson**, executive vice president corporate reservoir engineering at Apache Corp., will present, "Alpine High Overcoming Challenges to Make a Successful Play."

## Scoop and Stack plays

The Scoop and Stack plays in Oklahoma are also attracting attention in the efforts to acquire acreage that is economic at today's oil and gas prices. "Scoop and Stack are among the most profitable plays in the country," said **Steve Gardner**, senior vice president at Ryder Scott, who will present technical and commercial issues on the plays.

Returns advertised by the operators are in the 50- to 100-percent range at \$55-per-barrel oil, with Stack at the higher end. As is the case with many horizontal unconventional plays, completion design is a key driver to well performance and is undergoing continual refinement. "The general trends here are similar to other plays around the US — larger fracs and longer laterals," said Gardner.

## What's old is new: Andrews County, Texas

There are other targets besides unconventional. Contrarians are redeveloping lower cost conventional plays by applying advanced horizontal D&C techniques. Their targets are properties with known inventories, minimal drilling obligations and extensive well control that helps assure more technical certainty in estimated future production profiles.

For an example, one needs to look no further than in Andrews County, Texas. In 1929, a major oil find in the county caused a rush there, and by the 1950s, the oil business peaked with discoveries of more than 100 fields.

More than 70 years after its heyday, Andrews County properties, and other fields in the Central basin platform, are being redeveloped with vigor. Led by Forge Energy LLC, privately held independents are dotting the high plains with new horizontal wells.

**Natalie Brown**, reservoir engineering manager at Forge, will discuss the company's "unconventional thinking" there in developing the San Andres formation with low-risk, horizontal wells offsetting legacy vertical wells.

Know-how and available capital are the yin and yang in the industry. Newer private E&P companies, some with unfamiliar names, are flush with capital and are piloted by savvy owners and managers. In a shifting landscape, those U.S. companies are an emerging force, spending from coffers stuffed with billions of dollars in private capital.

## State, federal updates

Regulations, including some that are burdensome or confusing, are a fact of life to be dealt with by the E&P industry. In that spirit, the conference will feature experts discussing recent effects of legislation and what oil and gas companies are doing.

- **David Porter**, a principal at Swan Energy Inc. and a recent Texas Railroad Commission chairman, will discuss the state's abandoned-well-and-plugging program and regulatory problems arising from fluctuating oil and gas prices.
- **Bob Thibault**, an attorney in the energy practice group of Haynes and Boone LLP, will provide an update on the financial security requirements for plugging, abandonment and decommissioning on OCS (outer continental shelf) leases under the Bureau of Ocean Energy Management. "The 800-pound gorilla is dormant for now," he said.
- As in past conferences, **Marc Folladori**, also an attorney at Haynes and Boone, will present hot-button topics, issues and comment letters arising from reserves-disclosure rules of the U.S. Securities and Exchange Commission.

## Details

Conference attendees will receive digital versions (PDF files) of the presentations on USB drives, except any withheld by a speaker. These presentations will be posted on the Ryder Scott website at [ryderscott.com/presentations](http://ryderscott.com/presentations). **Larry Connor**, technical coordinator and advising senior vice president, manages the event.

Email requests, questions or comments to [RSCConfHouston@ryderscott.com](mailto:RSCConfHouston@ryderscott.com). Attendance is mostly by invitation only. However, a limited number of reservations are available to non-invitees depending on availability of seating.

Ryder Scott will also maintain a wait list of those requesting reservations but who are unable to be admitted because the event is fully booked and registration is closed. Those on the wait list may be admitted in place of those who cancel their reservations or who are no-shows.

Attending licensed petroleum engineers will receive six to eight hours of CEUs (Continuing Education Units). State-licensed engineers are required annually to maintain their licensing through continuing education.

Those who attend the ethics presentation at the reserves conference will receive a one-hour credit, which fulfills the annual requirement of most states for licensed engineers.

## High-side forecasts with type wells caused by "survivor bias," says Lee



## Good practices guard against inflated EURs

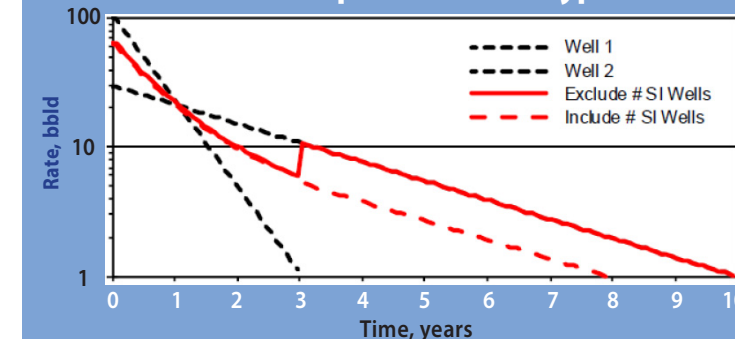
"Considerable anecdotal evidence suggests unintended, optimistic bias in type-well analysis," said **John Lee**, professor at Texas A&M University.

One cause is "survivor bias," where the evaluator drops depleted wells or wells with short histories from the well count while keeping only wells that survive the cut.

"Good practice dictates that the evaluator add the rates of all wells to the economic limit or expected well life on a monthly or regular basis, including zero rates from abandoned wells," said Lee, a member of the National Academy of Engineering.

That increases the number of wells used to divide total production resulting in a lower, more reliable average production curve. When the evaluator merges historical production data with production forecasts to build type wells, they represent the best available interpretation of the underlying data.

## Failure to Include Abandoned Wells with Zero Rates Ensures Upward Bias in Type Well



– SPE-162631, see full citation on technical paper at end of article.

## Auto-forecasting, rapid reviews cut analysis time

With an "assist," a reserves evaluator can reliably estimate ultimate recoveries from hundreds, sometimes thousands of wells, with little delay through type-well (type-curve) analysis. The assist and efficiency boost come from auto-forecasting.

To conduct type-well analysis more rapidly, evaluators are turning to algorithm-based, auto-forecasting routines featured in production-forecasting software programs. Used properly, they generate best-fit declines and decline models, including the commonly used two-segment Arps.

"Manual forecasting is prohibitively time consuming," said Lee. "However, rapid manual examination can eliminate unreasonable results in auto-forecasts."

Note: Lee said the term "type well" is a more apt than "type curve," because the latter name has already been taken and denotes a different petroleum-engineering process.

## Workflow for type well construction and application

In selecting wells for construction of the type well, the evaluator usually needs 200 or more wells with clearly defined trends and minimum noise. Then the wells are placed into distinct "bins," referred to as binning. Each bin should have 50 or more wells to ensure statistical confidence.

The wells are segregated by reservoir fluid type, e.g., dry gas, retrograde gas, volatile oil, black oil. Possible sorting parameters include the following:

- Geological similarity
- Date of first production (vintage)
- Fracture size and fracture fluid type

Please see *High-side forecasts* on page 6

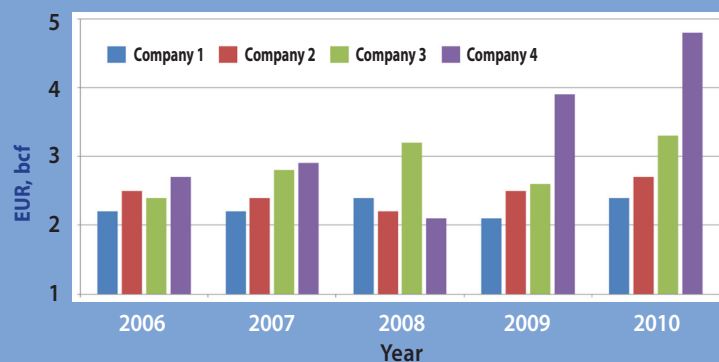


## High-side forecasts – Cont. from page 5

- Completion technique
- Well location and spacing
- Operational practices
- Operator
- Vintage

Lee cited a study that examined EURs in the Barnett shale that varied by operator and by vintage over five years. “The study makes the case that ‘binning’ using those parameters is a good approach. Technology has improved recoveries over time and operators have found better drilling locations,” he said.

### EURs in the Barnett Shale that Varied by Operator and Vintage more than 5 Years



– SPE-158867, see full citation on technical paper at end of article.

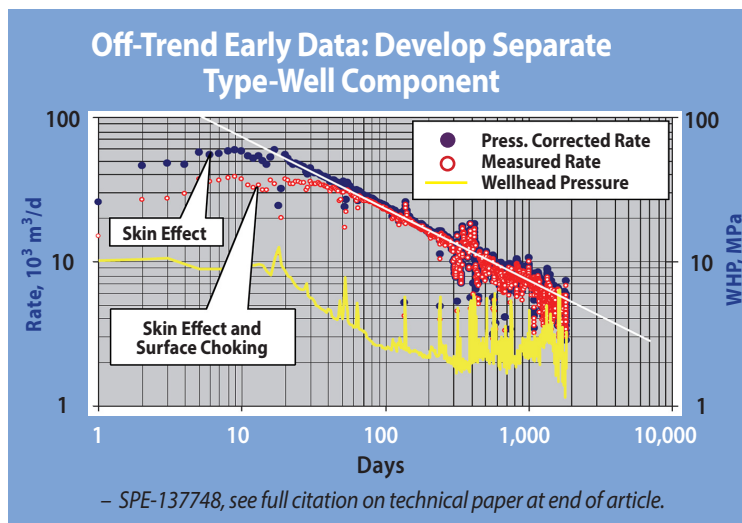
Lee said that to check whether a bin has wells with similar characteristics, plot the EURs and initial potential on a probit chart.

“That should yield a straight line. If you don’t find a straight line, you may have mixed apples and oranges in the bin,” he remarked.

Next, the evaluator prepares log-log rate-time diagnostic plots for each well in the sample set vs. grouping the wells. “It’s not a lot of extra work but it’s important,” Lee said.

Identifying flow regimes in those plots ensures that the forecast honors fluid-flow physics.

Lee also recommended that evaluators develop a separate type-well component or add-on segment for early, off-trend well data. “Exclude off-trend data from the fit, but don’t discard it,” he said. Causes for off-trend data can be early wellbore cleanup, skin effects that reduce permeability near the wellbore or surface choking causing pressure drawdown.



– SPE-137748, see full citation on technical paper at end of article.

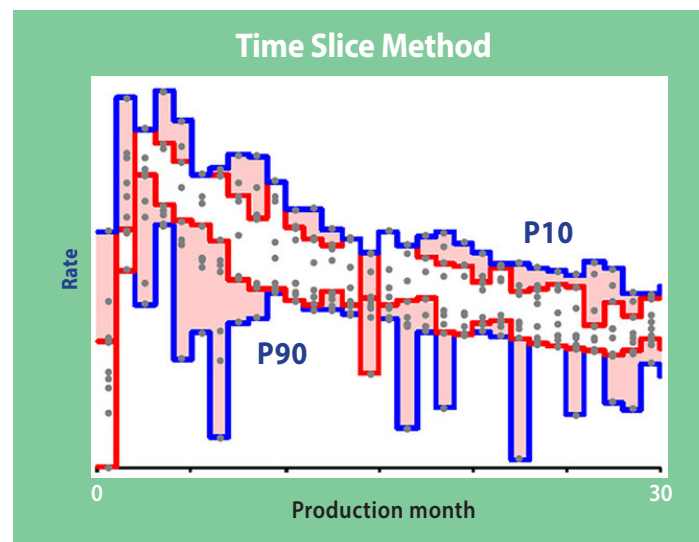
Lee said it’s important to scale data as needed with the goal of minimizing the number of separate bins and maximizing the number of wells in each bin. “You could sort by lateral length, but that practice could lead to an excessive number of bins,” he remarked.

Scaling for completed well lengths is not a linear relationship. “It’s not a straight line because we lose effectiveness, for instance, from pressure drops in the well casing along the wellbore,” said Lee.

He recommended sorting wells based on permeability-thickness, number of fracture stages and drawdown — all factors that affect post-peak rate well performance.

“You can sort wells by one of more of these factors, but keep in mind the need to limit the number of bins,” Lee said. “From peak rate to end of linear flow, permeability and fracture spacing will dominate well performance.”

Lee recommended that evaluators avoid the widely used time-slice method, which involves reordering monthly production of wells from largest to smallest. That causes individual well histories to cross each other on a rate-time plot, P90s to be too low and P10s to be too high.



### EUR from Type Wells

	Time Slice	Target EUR	Error
P 10	2174	2189	-1%
P25	1649	1832	-10%
P50	1190	1431	-17%
P75	887	1129	-21%
P90	588	909	-35%

– SPE-167215, see full citation on technical paper at end of article.

At the Ryder Scott Canada Reserves Conference in May, Lee showed various charts and graphs. His presentation is posted at [ryderscott.com/presentations/](http://ryderscott.com/presentations/).

Lee cited the following SPE technical papers in his presentation:

- “A Practical Guide to Unconventional Petroleum Evaluation,” B. Russell and R. Freeborn, Energy Navigator Inc., SPE 158867, 2012

## Geologist joins RS, seven employees promoted

Senior petroleum geologist **Luisa Rolon** joined the Ryder Scott Houston office earlier this year. She has more than 18 years of international and U.S. experience in the oil and gas industry, including extensive knowledge of geology and petroleum systems in a broad variety of geographic areas.

Rolon most recently worked at ENI Petroleum Co. Inc. where she was a senior exploration geologist/geophysicist for properties in the Gulf of Mexico and Mexico. She appraised discoveries, generated prospects in the eastern GOM and added prospective resources to the exploration portfolio.

Before that, she worked at Hess Corp. starting in 2011 for two years as a senior geologist/geophysicist. Rolon was lead development geologist for the Bakken play and technical lead in a Three Forks fluid system project.

She was also a geologist, seismic interpreter and prospect generator for offshore Peru and the Guyana-Suriname area, and prepared reservoir maps for plays in Brazil, Peru and Guyana-Suriname.



Luisa Rolon

- “How To Apply Stretched Exponential Equations to Reserve Evaluation,” R. Freeborn and B. Russell, Energy Navigator Inc., SPE-162631, 2012
- “An Unconventional Rate Decline Approach for Tight and Fracture-Dominated Gas Wells,” A. Duong, ConocoPhillips Canada, SPE-137748, 2010
- “Creating More Representative Type Wells,” R. Freeborn and B. Russell, Energy Navigator Inc., SPE-175967, 2015
- “Creating Analogs, Fact and Fiction,” R. Freeborn and B. Russell, W. Keinick, Energy Navigator Inc., SPE-162630, 2012
- “A Practical Guide to Unconventional Petroleum Evaluation Part 2,” B. Russell, R. Freeborn, Energy Navigator Inc., SPE-167215, 2013

Those papers are available for purchase through OnePetro at [www.onepetro.org](http://www.onepetro.org).

Rolon was a geophysicist, geologist and reservoir engineer at Chevron Corp. during 2004-2010. She was a lead geoscientist for exploration-and-development G&G for an offshore exploration project in the Campos and Santos basins in Brazil.

Rolon evaluated the complex geology of the Atlanta and Oliva fields in BS-4 block offshore Brazil and her estimate added significant potential upside resources, resulting in a successful divestiture. She was also development and lead geologist for an east Texas asset. Rolon identified new uphole recompletion zones for tight-gas development. Rolon was also a reservoir engineer and generated well production forecasts for a south Texas asset.

She was a regional stratigrapher/sedimentologist at Ecopetrol SA in Colombia for four years starting in 1997. Rolon was a technical leader for stratigraphic and sedimentological analysis in the Middle Magdalena/Eastern Cordillera basins in Colombia. She developed new reservoir and paleo-environmental maps at the basin level and prepared risk mapping.

Rolon founded Geosurvey Ltda in Colombia in 1995 to 1997 and served as the managing director. She led a team of as many as seven geologists in surface geology campaigns. Rolon performed seismic analysis, stratigraphic mapping and rock sampling to generate exploration leads.

Rolon has a BS degree in geology and geophysics from Colombian National University and MS degrees in petroleum engineering and geology from West Virginia University. She is fluent in several languages.

Please see *Geologist joins RS* on page 12



# New approaches to type-well analysis put to the test in Cardium play



Vitaliy Charkovskyy

**Vitaliy Charkovskyy**, senior petroleum engineer at Ryder Scott Canada, presented the latest practices in type well development and application, which he tested in a region of the Cardium tight oil play in Western Canada. Operators in the unconventional Cardium are drilling multi-stage, hydraulically fractured horizontal wells to increase production.

Charkovskyy started his five-day study with 242 analog horizontal wells in a single geological subset area of the play. The development plan called for the drilling of five horizontal wells in 2017.

## Analog, flow-regime identification and production forecasts

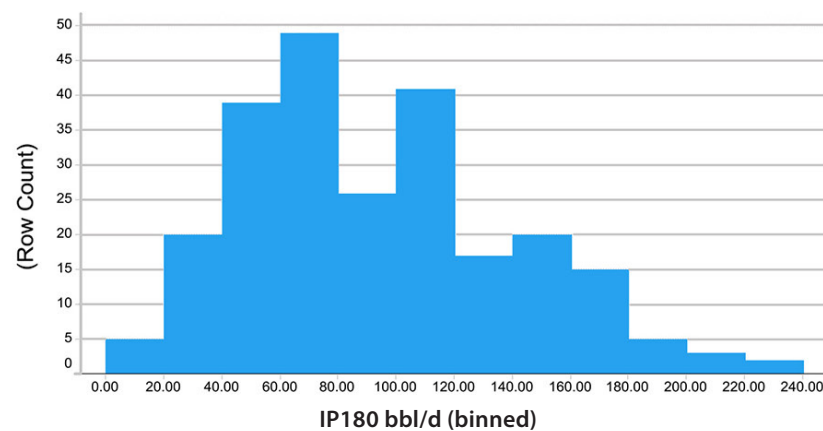
The steps in the work flow started with clearly defining objectives. “Why do we need a type well and where we are going to apply it,” asked Charkovskyy.

He used the type well to forecast 20 producers with short histories in his sample (spudded in 2015 and 2016) and to estimate undeveloped reserves of future drilling locations.

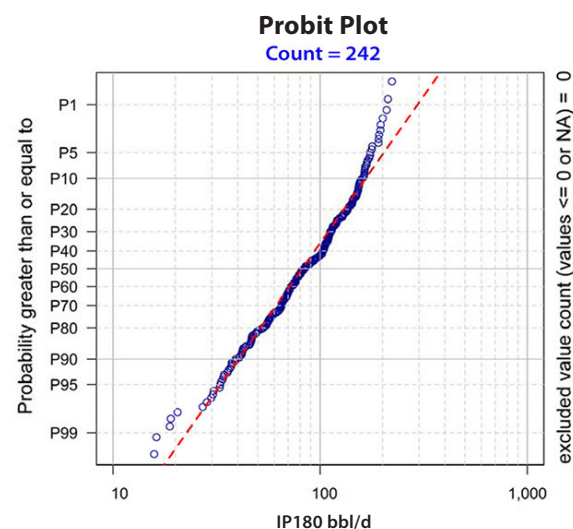
The second step was to define a geological subset area. “Although some geological properties varied, such as net pay and permeability, there was enough homogeneity that behavior of our wells within the geological subset can be described by a statistical distribution,” he said. “Selecting the appropriate analog is arguably the most important part of type well construction.”

To ensure against mixing of different geological trends in the dataset, Charkovskyy performed a diagnostic validation. He populated a probit plot with initial production (IP) of all 242 wells to get an average (mean) well IP (IP180 on chart below) of 94 BOPD. The IP measures were log normally distributed and fell on a straight line between P10 and P90. A low P10-to-P90 ratio of 4 suggested sampling from a single distribution, he said.

## Geological Subset – Diagnostic Validation



P10/P90 = 4.12    Mean IP180 = 94 bbl/d    P10 IP180 = 165 bbl/d    P50 IP180 = 81 bbl/d    P90 IP180 = 40 bbl/d



Charkovskyy then built diagnostic plots for all wells. Log-log rate time and log-log rate material balance time (MBT) are used frequently when analyzing unconventional wells.

“MBT is often a preferred choice to the simpler rate-time plot, but unfortunately, MBT also requires special treatment,” Charkovskyy said.

Material balance time should always follow the chronological order of real time. However, ensuring that it does is not enough. Abnormally low rates produce abnormally large MBTs and very often fall on a false unit slope.

“Failure to filter out bad MBT points very often leads to mistakes in flow-regime identification,” said Charkovskyy.

Before building the MBT plots, Charkovskyy removed outliers in production data through the local outlier factor method developed by **Nitinkumar L. Chaudhary** at the University of Houston and **John Lee** at Texas A&M University. Charkovskyy said that the Chaudhary-Lee machine-learning technique is speedier than manual outlier removal. The technique also assumes less than the SPEE (Society of Petroleum Evaluation Engineers) Monograph 4 method of filtering out all points two to three standard deviations from the good-fitting decline model.

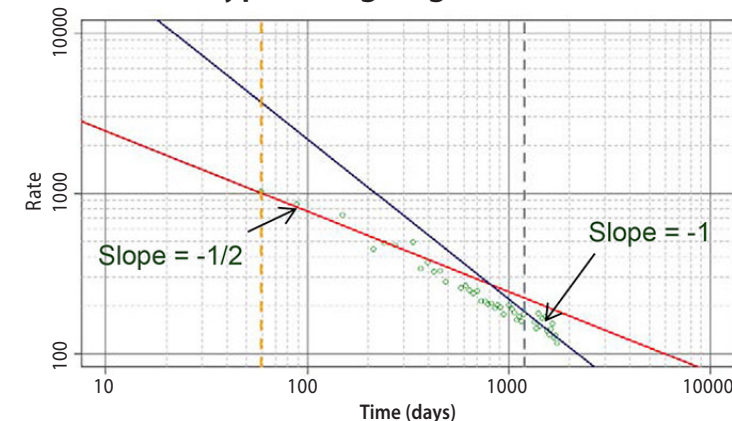
“The Monograph 4 method assumes knowledge of the fitting model and forecasting wells before removing the outliers,” said Charkovskyy, while the Chaudhary-Lee method requires minimal input from the analyst.

From his diagnostic work, Charkovskyy found that early production data was affected by operator practices, early linear flow was followed by a long transition period, and linear flow was not observed in some wells

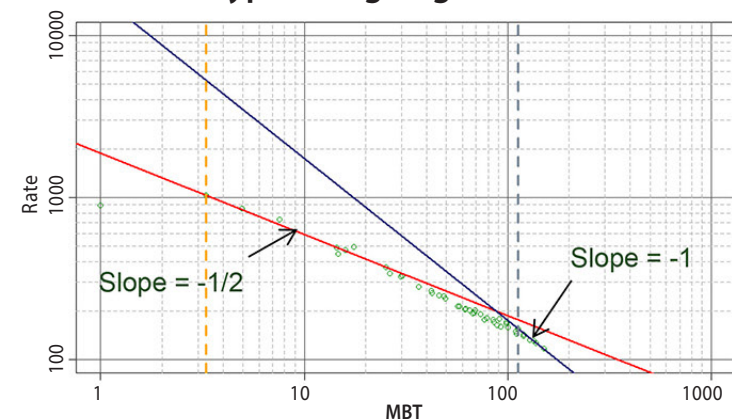
at all, most likely because of varying bottomhole pressures and significant fracture skin.

## Diagnostic Work on Flow Regimes

### Typical Log-Log Rate-Time



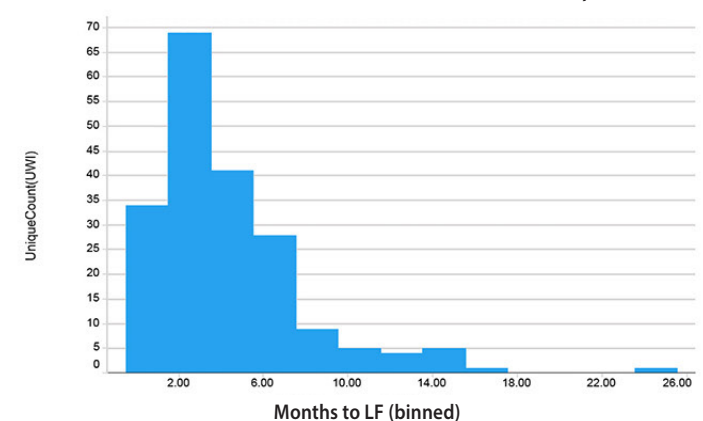
### Typical Log-Log Rate-MBT



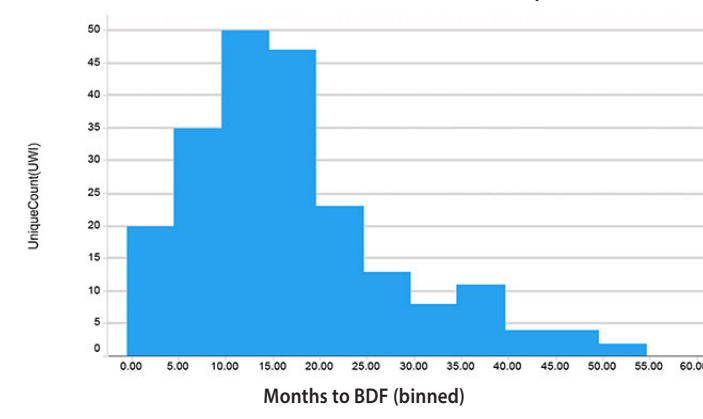
Besides identifying flow regimes, the purpose of the diagnostic plots was to estimate Arps b factors for wells already in boundary-dominated flow. “Pressure-normalized rates should always be used in diagnostic plots, if available. Using normalized rates greatly improves the quality of the diagnostic analysis by removing the effect of changing bottomhole pressures,” said Charkovskyy.

After building diagnostic plots and identifying flow regimes, Charkovskyy used the information to guide his construction of full-life production forecasts for all wells in the dataset.

### Total Dataset Results – Time to Linear Flow, Months



### Total Dataset Results – Time to BDF, Months



Before applying a type well to new drilling, Charkovskyy brought the validation wells back into the type well and renormalized.

Forecasting newer wells with shorter production histories and no established decline trends can introduce bias to a simple decline-model forecast. However, those wells cannot be ignored, said Charkovskyy, whose solution was to exclude new wells from the initial type-well development, apply the type-well profile to excluded wells, bring them back and renormalize the type well.

## Binning, scaling and type-well validation

After forecasting, Charkovskyy created bins for the wells, in addition to the geologic binning. See binning basics by John Lee on Page 5, “High-side forecasts with type wells caused by survivor bias.”

Charkovskyy’s binning options included fluid type, well vintage, operator, fracture size and completion fluid, completion technique, well location and spacing.

Gas-oil ratio (GOR) for fluid types was not a binning criterion. The wells were oil only, and a histogram of six-month average GORs showed only black oil wells.

Vintage was not a binning criterion. All wells were drilled after 2009 and completed with modern techniques, which eliminated with the need to bin by vintage in this case.

“There was no clear correlation between EUR or average well IP to the change in completion practices over the years,” said Charkovskyy, who noted that on average, operators in the Cardium had been drilling longer wells and increasing the number of frac stages over the years.

“There was also some experimentation with frac fluid and fairly consistent use of the ball-and-seat completion technique,” said Charkovskyy.

*Please see New approaches on page 10*



### New approaches – Cont. from page 9

Binning by operator, which is commonly done, was not practical because seven of nine had few wells, which would have created too few wells per bin.

“The idea behind binning by operator is that single operator will use consistent completion techniques,” said Charkovsky. He binned all wells within the geological subset by completion technology, completion fluid and frac spacing.

Next, Charkovsky scaled all wells in the three defined bins to target stimulated lateral length. To do that, Charkovsky took into account that each bin contained wells completed with the same technology, fluid and frac spacing but stimulated lateral length varied.

“A logical next step was to scale all wells within each bin to the target stimulated lateral length,” he said. “Linear scaling appears to be a standard industry practice and a common method at the moment, but the relationship between stimulated lateral length and EUR or IP cannot be linear,” said Charkovsky.

He cited three reasons why scaling is non-linear:

- Significant pressure drops exist in the wellbore. Exposure time increases with lateral length.
- Chances of drilling out of the target zone increase with lateral length.
- Ability to place effective fracs decreases with lateral length.

“It is not a surprise that we don’t get a linear relationship in our data set,” said Charkovsky. When he tried to fit a linear regression to length vs. EUR or length vs. average well IP, the regression coefficient was very poor

and varied from 0.1 to 0.4.

Charkovsky’s answer was to use what he called a better scaling method introduced by **Randy Freeborn** and **Boyd Russell** at Energy Navigator Inc. They developed a correlation for scaling to target length based on empirical data from Bakken wells and the results are a non-linear relationship.

“Non-linear scaling to the stimulated lateral length is certainly a step forward compared to the standard industry practice. However, because the method was developed based on a relatively small sample of Bakken wells, the question remains if the method can be universally applied to any play or part of the play,” said Charkovsky.

He suggested that reservoir simulation with wellbore-hydraulics modeling can potentially validate the scaling method. Repeating the empirical study would also help with validation.

With all wells binned and scaled to the target length, Charkovsky validated the type well for a reality check. He selected a few validation wells from each of the three bins, excluded them from the dataset, scaled production histories and forecasts for the wells left in each bin to the lengths of validation wells, and constructed a type well from scaled production.

The type well aligned with the actual history from the six validation wells and resulted in good matches on rate-time and rate-cum plots. The shape of the type well realistically represented actual production histories.

### Bin 1 — Practical Method

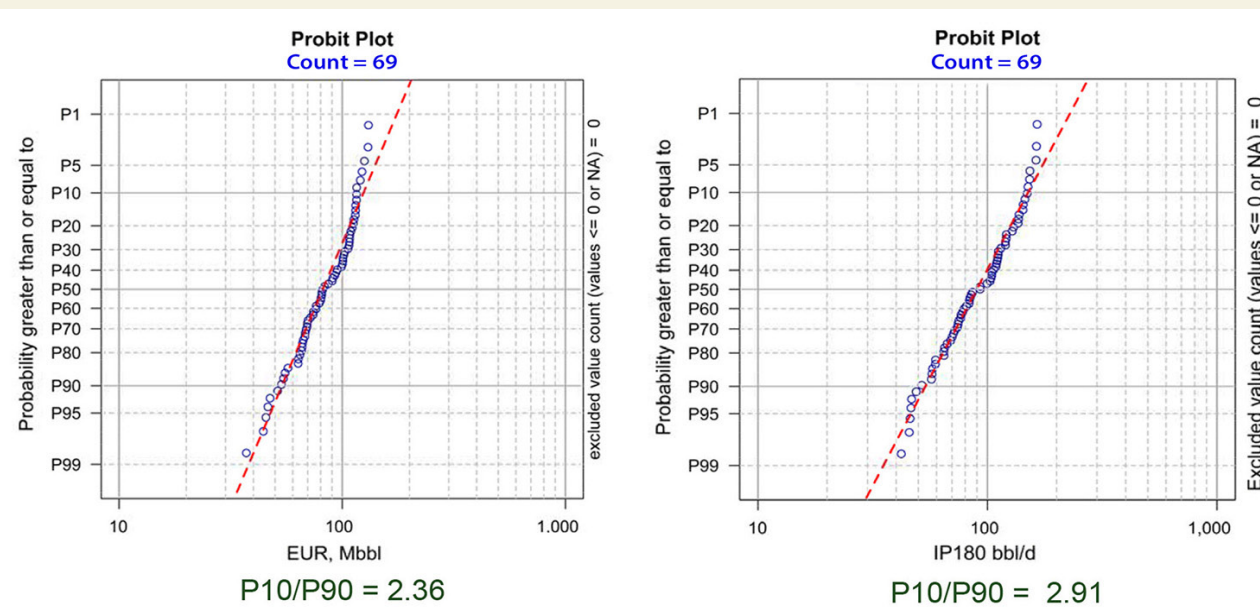
**Technology:**  
Ball and Seat

**Fluid:**  
Slickwater and Water

**Frac Spacing:**  
60-70 m

**Proppant per stage:**  
20-30 t

Bin 1, with frac spacing between 60 and 70 meters, had the lowest P10-to-P90 ratios for EURs and IPs.



### New drilling, aggregation and depletion

Before applying a type well to new drilling, Charkovsky brought the validation wells back into the type well and renormalized. Also, he applied the type well to wells with short production histories and brought them back to the type well.

The development plan called for drilling five 2000-meter horizontal wells, each with 26 frac stages, ball-and-seat completions and slick water as the frac fluid. Charkovsky scaled production from the appropriate bin to target lateral lengths of 2000 m and developed a type well with a scaled production history and forecast.

“Since our drilling program is more than one well, appropriate statistical aggregation principles should be applied,” said Charkovsky. “Aggregation methods account for the size of the drilling program and calculate weighting factors using Monte Carlo simulation in proportion to the probability of the well being drilled for a given program size.”

He developed P10/P50/P90 type wells using the aggregation method. P10 decreased with an increased well count, P50 remained almost the same, and P90 increased as dictated by the effect of statistical aggregation.

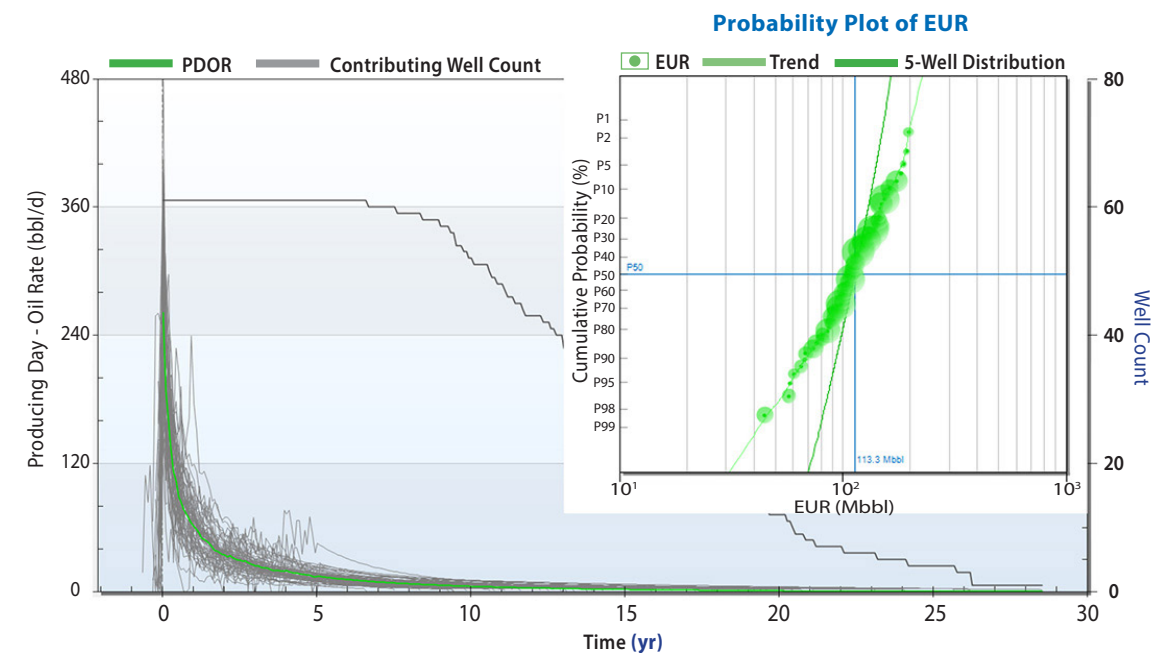
“Or in simpler terms, there is less uncertainty of EUR deviating from the P50 expectation as the well count increases,” Charkovsky said.

If a type well is applied to infill drilling or in a region with prior drainage from vertical wells, the analyst has to account for depletion. Typical

industry practice is to add depletion factors to type well forecasts used late in a development plan.

Charkovsky presented at the RS Canada Reserves Conference in May. All conference presentations are at [ryderscott.com/presentations/](http://ryderscott.com/presentations/).

### P50 Type Well

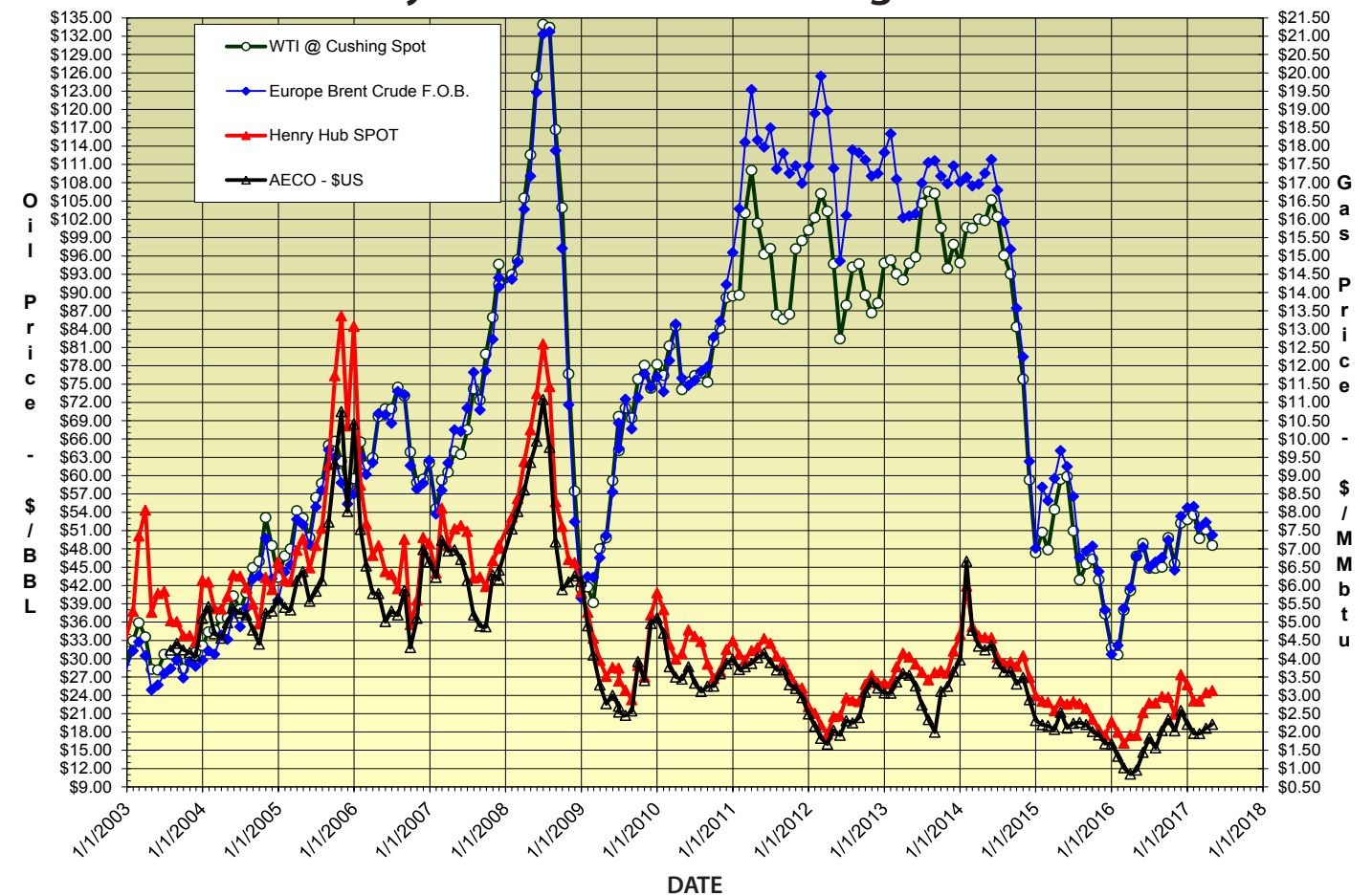


Select Well Method:  
P50 EUR = 110 Mbbbl

Aggregation Method  
(drilling 5 wells):  
P50 EUR = 113.3 Mbbbl

Using the aggregation method, P50 volumes remained relatively the same with increased well count.

### Price history of benchmark oil and gas in U.S. dollars



Published, monthly-average, cash market prices for WTI crude at Cushing (NYMEX), Brent crude and Henry Hub and AECO gas.

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*Geologist joins RS – Cont. from page 7*

### Promotions and awards

The following employees at Ryder Scott were promoted as follows:

- **Marylena Garcia** to senior vice president-group coordinator
- **Gabby Morrow** to senior vice president-group coordinator
- **Ali Porbandarwala** to senior vice president-group coordinator
- **Adam Cagle** to senior petroleum engineer
- **Gilly Rosen** to senior petroleum geoscientist
- **Beau Utley** to senior petroleum engineer
- **D.J. Jeong** to senior engineering technician

**Scott Wilson**, senior vice president at the Denver office of Ryder Scott, won the **SPE Rocky Mountain Regional Award for Reservoir Description and Dynamics**. He received the award from the SPE Denver section in May.

### Publisher's Statement

*Reservoir Solutions* newsletter is published quarterly by Ryder Scott Co. LP. Established in 1937, the reservoir evaluation consulting firm performs hundreds of oil and gas reserves studies a year. Ryder Scott multi-disciplinary studies incorporate geophysics, petrophysics, geology, petroleum engineering, reservoir simulation and economics. With 130 employees, including 90 engineers and geoscientists, Ryder Scott has the capability to complete the largest, most complex reservoir-evaluation projects in a timely manner.

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