Executive Summary

November brings you another relevant issue of *SPE Reservoir Evaluation & Engineering* (*SPE Res Eval & Eng*). I would like to welcome new associate editors Mark Kittridge and Andrés Yrigoyen. Mark brings more than 30 years of petroleum-engineering experience, including physics of rocks and general formation evaluation, whereas Andrés will use his more than 20 years in the industry to support us in the areas of petroleum economics, reservoir engineering, and field development. The staff and editorial committee of *SPE Res Eval & Eng* truly appreciate the contribution of those volunteers who give of their time as associate editors, technical reviewers, and authors.

This last issue of 2018 comprises 17 papers on the the special topic of unconventional resources. I would like to thank former executive editor Gary Teletzke for serving as guest editor and leading the design of this special issue. Gary wrote a piece that appeared in the October issue of *JPT*, highlighting the growth of unconventional resources in the last decade and how the literature, particularly peer-reviewed papers related to unconventional resources published in this journal, has experienced similar growth. I also extend my gratitude to my co-executive editor Jasper Ring for helping in the editorial process and selection of the various papers presented in this issue.

Unconventional Resources—Special Issue

—**Gary Teletzke,** *SPE Res Eval & Eng* Guest Editor, ExxonMobil Upstream Research Company

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Characterization of Nanoporous Systems

Understanding the pore-scale structure and fluid transport in nanoporous rocks is fundamental to optimal development of unconventional resources. We present two papers that deal with characterization and modeling of nanoporous systems. **Multiscale Fluid-Phase-Behavior Simulation in Shale Reservoirs Using a Pore-Size-Dependent Equation of State** by Luo et al. presents a study on the effect of pore-size distribution on the phase behavior of shale-reservoir fluids in a multiscale pore system. The authors find that the presence of nanopores can significantly lower apparent bubblepoint pressure. They further discover that, during depletion, intermediate-to-heavy components are retained in the nanopores in the form of undersaturated fluids. **Integration of Large-Area Scanning-Electron-Microscopy Imaging and Automated Mineralogy/Petrography Data for Selection of Nanoscale Pore-Space Characterization Sites** by Kazak et al. describes a new multiscale automated digital rock modeling workflow for representatively retaining a large volume of a rock sample while achieving nanoscale resolution of pore space and mineral distributions. The application of the workflow is demonstrated by means of an analysis of a rock sample taken from the Berezov Formation tight gas formation, where characteristic dimensions of void-space elements span from single nanometers to millimeters.

Petrophysics of Mudrocks

The complexity of rock fabric in organic-rich mudrocks has a significant impact on rock properties, such as electrical resistivity, and, consequently, on hydrocarbon volume estimate. In **A New Workflow for Improved Water-Saturation Assessment in Organic-Rich Mudrocks Honoring Rock Fabrix,** Posenato Garcia et al. propose a new resistivity-based workflow that quantitatively accounts for the type and spatial distribution of all conductive components in the rock bulk volume. Advanced rock-imaging techniques are used to quantify rock features that are entered into the model. The authors successfully apply the method to pore-scale rock samples that include one organic-rich rock sample and several synthetic cases, and observe considerable improvement when compared with traditional saturation methods.

Geomechanics of Shales

Characterization of the geomechanical properties of shales is important to the design of drilling, completion, and stimulation programs for optimized production. In addition, coupling of geomechanical and fluid-flow models is essential for analysis and prediction of unconventional production performance. **Impact of Anisotropy Induced by Shale Lamination and Natural Fractures on Reservoir Development and Operational Designs** by Gu investigates the effects of two types of shale anisotropy on geomechanical-property characterization of shale rocks. Gu discusses the implications for drilling/completion/stimulation designs. **Transient-Rate Analysis of Stress-Sensitive Hydraulic Fractures: Considering the Geomechanical Effect in Anisotropic Shale** by Yao et al. includes the effect of stress-sensitive hydraulic fractures and shale anisotropy to semianalytically model hydrocarbon-flow dynamic in reservoirs with multistage hydraulically fractured horizontal wells (MHFHWs). The

model is used to analyze two field cases with different flowing-bottomhole-pressure profiles under the influence of stress-sensitive hydraulic fractures, which provides crucial insights to optimize and monitor fracture treatments, especially in shale reservoirs.

Stimulated Reservoir Volume (SRV) Characterization

Understanding complex fracture networks and their interaction with the low-permeability matrix rock is essential for prediction of unconventional reservoir performance. In this vein, three papers deal with characterization and modeling of the SRV associated with MHFHWs. **Evolution and Evaluation of SRV in Shale Gas Reservoirs: An Application in the Horn River Shale of Canada** by Urban-Rascon et al. proposes a hybrid-hydraulic-fracture (HHF) model composed of (1) complex discrete fracture networks (DFNs) and (2) planar fractures for modeling the SRV associated with MHFHWs. The HHF approach is used to characterize and evaluate the SRV in nine horizontal multilaterals in the Horn River Shale, leading to a good match of the post-fracturing production history and insights into the characteristics of the complex hybrid fracture network. **Determination of Performance of Multiple-Fracture Horizontal Well by Incorporating Fracture-Fluid Leakoff** by Asadi et al. introduces a new modeling approach to evaluate the effect of fracture-fluid leakoff on fracture characteristics during hydraulic fracturing. The proposed methodology is applied to a synthetic case study to evaluate the influence of fracture-fluid leakoff on the productivity index and to obtain the fracture dimensions that result in the optimal productivity. **Sampling a Stimulated Rock Volume: An Eagle Ford Example** by Raterman et al. describes design, execution, and results of a pilot project consisting of five deviated wells drilled adjacent to an MHFHW to sample the physical characteristics of the SRV caused by hydraulic fracturing in the Eagle Ford Formation. The pilot enabled determination of the spatial characteristics of the SRV using information derived from core, cuttings samples, borehole image logs, tracer logs, microseismic, distributed temperature surveys/distributed acoustic surveys, and pressure data, leading to an improved understanding of the complex characteristics of the SRV.

Hydraulic-Fracture Modeling

Three papers describe progress toward developing efficient and realistic workflows to model hydraulic fractures in unconventional reservoirs. In **Flow Interference Between Hydraulic Fractures,** Weijermars et al. test a newly developed analytical streamline simulator to visualize flow toward hydraulic fractures at high resolution. They present how drainage contours show progressive fluid recovery from the SRV and the drained rock volume on the basis of particle-velocity tracking in MHFHWs. One of the leading conclusions of this work is that longer singular fractures are preferred over tightly spaced clusters. **Semianalytical Solution for Modeling the Performance of Complex Multifractured Horizontal Wells in Unconventional Reservoirs** by Idorenyin and Shirif introduces a semianalytical solution for modeling the performance of complex MHFHWs in unconventional reservoirs. The authors claim that their workflow overcomes the limitations presented by simplified analytical solutions and thereby expands analysis to the realm of reservoir/well architectures that are inaccessible to analytical methods. By applying this method to field and synthetic examples, they demonstrate the utility of the method for modeling variable-rate flow observed in actual field-production scenarios and show its potential for history matching and forecasting the performance of MHFHWs. Finally, **Performance-Based Comparison for Hydraulically Fractured Tight and Shale-Gas Reservoirs With and Without Non-Darcy-Flow Effect** by Al-Rbeawi investigates the effect of non-Darcy flow on pressure profiles, flow regimes, and productivity indices of multiple hydraulic fractures that propagate in tight and shale reservoirs. The chief contribution of this paper is the ability to estimate rate-dependent skin factor and non-Darcy-flow coefficient without performing experimental studies or using an empirical model.

Dynamic Modeling and Production Forecast in Unconventional Reservoirs

Continuing on the theme of modeling MHFHWs, four papers describe new approaches for dynamic modeling of production from shale-gas and tight oil reservoirs. **Integration of Support Vector Regression With Distributed Gauss-Newton Optimization Method and Its Applications to Uncertainty Assessment of Unconventional Assets** by Guo et al. proposes an efficient optimization algorithm for assisted history matching and uncertainty analysis of reservoir simulation models of unconventional resources. The approach was tested with a real field history match example of an MHFHW in a Permian Basin liquid-rich shale reservoir. **Modeling of Methane/Shale Excess Adsorption Under Reservoir Conditions** by Yang et al. proposes a new model to account for volume changes during measurements of gas adsorption at high temperature and pressure. The model provides insight into the effects of adsorbent swelling, shrinkage, and gas absorption onto organic matter on gas adsorption at reservoir conditions. **Use of Dynamic Data and a New Material-Balance Equation for Estimating Average Reservoir Pressure, Original Gas in Place, and Optimal Well Spacing in Shale Gas Reservoirs** by Orozco and Aguilera introduces a methodology for calculating average reservoir pressure, original gas in place, drainage area, and optimal well spacing in shale reservoirs through the combination of dynamic data and a new material-balance equation that considers simultaneously the effects of free, adsorbed, and dissolved gas. Production data from two MHFHWs in the Horn River Shale are used for testing the effectiveness of the new methodology. **Variable**

Exponential Decline: Modified Arps To Characterize Unconventional-Shale Production Performance by Gupta et al. proposes a simplified power-law decline-curve equation by modifying the Arps exponential-decline model. The authors apply their new equation using production data from Haynesville and Eagle Ford Formations, and find that the average error in cumulative-production prediction for 20 wells is 3% and 2%, respectively. Their method can account for different flow regimes and changes in fracture conductivity with time.

Enhanced Oil Recovery in Tight Reservoirs

Recovery from tight oil reservoirs under primary production currently averages only 5 to 10% of the original oil in place; improving recovery is a very active area of investigation. Two papers describe emerging technologies for improving recovery from tight liquid reservoirs. **Coupling of Wellbore and Surface-Facilities Models With Reservoir Simulation To Optimize Recovery of Liquids From Shale Reservoirs** by Fragoso et al. highlights the importance of integrating reservoir, wellbore, and surface-facility models to optimize recovery from shale reservoirs, especially when there is significant compositional variation within the reservoir. The integrated model is used to explore novel schemes for maximizing liquid recovery from the Eagle Ford Shale. **Improving Oil Recovery in the Wolfcamp Reservoir by Soaking/Flowback Production Schedule With Surfactant Additives** by Alvarez et al. evaluates the ability of different groups of surfactants to improve oil recovery in unconventional liquid reservoirs (ULRs) by experimentally simulating the fracture treatment to represent surfactant imbibition in a ULR core fracture during soaking and flowback. The laboratory results suggest that the addition of surfactants to completion fluids and the use of a soaking/flowback production scheme could improve oil recovery by wettability alteration and interfacial-tension reduction, maximizing well performance after stimulation.

Conclusion

In addition to the papers presented in this issue, six papers related to unconventional resources were spotlighted in the May 2018 issue. Taken together, the papers published in these two issues of *SPE Res Eval & Eng* provide a snapshot of the rapidly evolving suite of technologies that are currently being applied for exploitation of unconventional resources. Although there has been tremendous progress over the past decade, we have only begun to scratch the surface of technology required to fully realize the potential of the vast worldwide store of unconventional resources. Surely more advances are yet to come.

The editorial board has made every effort to bring you a robust issue by selecting innovative and useful manuscripts from industry and academia. All papers were carefully reviewed by at least two technical reviewers under the coordination of an associate editor. However, conclusions and interpretations stemmed from these papers are opinions and observation of the authors. I would like to express my appreciation to the technical reviewers who selflessly dedicate their time to perform outstanding reviews in an effort to maintain the quality of our journal.

Because knowledge sharing, and open discussions are important, SPE welcomes further discussion from our readers. I look forward to receiving discussion letters.

Hope you enjoy these outstanding papers!

Jesús M. Salazar, *SPE Res Eval & Eng* Executive Editor,
Marathon Oil Company, Houston

2018 Outstanding Technical Editor Awards

Every year, SPE recognizes members who have made an exceptional effort to ensure the technical excellence of the Society's peer-reviewed journals. For their contributions, the following individuals are recipients of the 2018 Outstanding Technical Editor Award for *SPE Reservoir Evaluation & Engineering*:

Mohammed B. Alotaibi, Saudi Aramco

Abdulkareem M. AlSofi, Saudi Aramco

Anil K. Ambastha, Chevron

Yani C. Araujo, SGS

Subhash C. Ayirala, Saudi Aramco

Reza Barati, University of Kansas

Clarke Bean, Chevron

Steffen Berg, Shell Global Solutions

Ronald Bonnie, ConocoPhillips Corporate Contributions

Garfield R. Bowen, Ridgeway Kite Software

Orlando Castellanos Diaz, Dow Chemical Canada

Zhiming Chen, University of Petroleum China-Beijing

Torsten Clemens, OMV Exploration & Production

Edward A. Clerke, Saudi Aramco

Peter J. Clifford, BP Exploration

Hugh Daigle, The University of Texas at Austin

Eric Delamaide, IFP Technologies Canada

William Scott Dodge, Virtual Petrophysics

Adolfo D'Windt, Kuwait Oil

Li Gao, Halliburton

Abhishek Gaurav, Texas Standard Oil

Leo A. Giangiacomo, Extreme Petroleum Technology

Fatosh Gozalpour, Chevron

Ming Gu, West Virginia University

Siavash Hakim-Elahi, University of Southern California

Donald G. Hill, Hill Petrophysics and University of Southern California

Mohammad Kariznovi, Canada Husky Energy

Gavin Longmuir, Consulting Petroleum Engineers

Ranran Lu, The University of Tulsa

Mohamed Mahmoud, King Fahd University of Petroleum and Minerals

Hassan Mahani, Shell

Raj Malpani, Schlumberger

David Medellin, The University of Texas at Austin

Somnath Mondal, Shell Upstream Americas

Gopi Nalla, DeGolyer and MacNaughton

Ryosuke Okuno, The University of Texas at Austin

Douglas G. Peck, BHP Billiton

Michael J. Pyrcz, The University of Texas at Austin

Rajagopal S. Raghavan, R Raghavan

David Rousseau, IFP Energies Nouvelles

Pierre Samier, Total

Randall S. Seright, New Mexico Institute of Mining & Technology

Vijay K. Shrivastava, Computer Modelling Group

Vural S. Suicmez, Quantum Reservoir Impact

Mohammadali Tarrahi, Shell Global Solutions

Diederik W. van Batenburg, Shell Global Solutions

Lee E. Whitebay, Whitebay & Associates

Jesse Williams-Kovacs, Consultant

Errata Notice

SPE-189982-ER
(*SPE Res Eval & Eng* **21** (2): 291–306. **https://doi.org/10.2118/189982-PA**)

This paper has been modified from its original version to include the following corrections: Katie M. Smye was added as the fourth author in the byline on page 291 and the author biographies on page 306. An Acknowledgments section was also added to page 305. No other content was changed and page numbering was not affected.

SPE-175907-ER
(*SPE Res Eval & Eng* **21** (2): 392–404. **https://doi.org/10.2118/175907-PA**)

This paper has been modified from its original version to include erratum SPE-175907-ER, which corrects the captions of Figs. 2 and 3 on pages 395 and 396. This change affects these captions only; no other content was changed.