Monday, October 28, 2019

HGS North American Dinner Meeting

Norris Conference Centers • 816 Town and Country Blvd #210
Social Hour 5:30–6:30 p.m.
Dinner 6:30–7:30 p.m.

Cost: $40 Preregistered members; $45 non-members/walk-ups

To guarantee a seat, pre-register on the HGS website & pre-pay by credit card.
Pre-registration without payment will not be accepted.
Walk-ups may pay at the door if extra seats are available.

If you are an Active or Associate Member who is unemployed and would like to attend this meeting, please call the HGS office for a discounted registration cost. We are also seeking members to volunteer at the registration desk for this and other events.

Abstract 1

Stratigraphic Controls on the Connectivity and Flow Performance of Deep-water Lobe-dominated Reservoirs

Fabien J. Laugier *and* ***Morgan D. Sullivan***
Chevron Energy Technology Company Clastic Stratigraphy Team
Michael Pyrcz
Department of Petroleum Engineering,
The University of Texas, Austin
Laura Murray
Chevron Gulf of Mexico Appraisal

Sand-prone deepwater lobes are conventionally modeled at reservoir scale as laterally extensive and homogeneous; however, recent work shows that in deep-water lobe systems stratigraphic architecture is spatially variable and complex, with facies and reservoir quality varying across multiple hierarchical orders (bed, element, complex, complex set). Here we consider the impact that these hierarchical variations have on reservoir connectivity and performance forecasts for high-net deep-water lobe reservoirs. We investigate the degree and style of heterogeneities observed in outcrop and subsurface systems, focusing on variability in: (1) distribution of facies and reservoir quality; (2) presence and nature of shale drapes; and (3) dimensions and stacking patterns.

We present results from >3000 process-mimicking (PM) reservoir models that capture realistic lobe geometries, stacking patterns, and internal heterogeneities. Using statistical analyses of flow simulation results we quantitatively identify the key stratigraphic features and hierarchies impacting reservoir connectivity, sweep efficiency, and flow performance, and critically, highlight the predictability of their impact in deep-water lobe reservoirs. Intra-element flow is limited by bed-to-element scale facies and amalgamation trends, while reservoir-scale flow is limited by spatial connectivity of amalgamated high-quality facies across element-to-complex-set stacking patterns. Results indicate fine-scale features, those least captured via common geostatistical techniques, are a primary control on connectivity; element-scale spatial trends of NTG, facies amalgamation and reservoir quality can reduce sweep efficiency by 22% due to transitional compartmentalization, while accurate modeling of 3D shale-drape geometry rather than modeling flat permeability barriers, can reduce sweep efficiency 20%. In contrast to the conventional assumption that fine-scale heterogeneities have limited impact in high-net lobe reservoirs, we show that these heterogeneities compound over hierarchical orders to result in a non-linear decrease in connectivity; even a low proportion of shale drapes in certain element-scale stacking patterns can form composite, complex-wide barriers. We conclude that fine-scale heterogeneities need to be rigorously characterized and captured in reservoir models at their appropriate scales for robust well optimization and production forecasting in deep-water lobe reservoirs such as the those in the Paleogene Wilcox Formation. ■

Abstract 2

Stratigraphic Surface-based Modeling of Deep-water Reservoirs: Application to an Ultra-deep Gulf of Mexico Wilcox Asset

Laura Murray
Chevron Gulf of Mexico Appraisal
Fabien J. Laugier *and* ***Jesse Thompson***
Chevron Energy Technology Company Clastic Stratigraphy Team
Rhonika Kaplan
Chevron Energy Technology Company Reservoir Modeling Team

Stratigraphic heterogeneity in clastic reservoirs is mainly driven by the process-evolution of depositional systems, the collective stratigraphy being the result of deposition and erosion over time. While deep-water reservoirs are often high-net, recent studies have indicated that fine-scale heterogeneities such as hierarchical

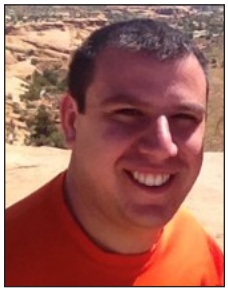
facies distributions, shale drapes, and high permeability streaks can impact reservoir performance predictions. Areas where seismic resolution can be low and well data are sparse, such as the Paleogene Wilcox reservoirs of the Gulf of Mexico (GoM), it is paramount to integrate subsurface data and outcrop analogs to appropriately characterize and model the reservoir heterogeneities that are crucial for constraining field development strategies and EUR forecasts. The issue of appropriately modeling multi-scale reservoir heterogeneity is addressed here using a process-mimicking (PM) approach to model the surface-based evolution of deep-water channels and fans and their associated multi-scale distribution of rock properties. The limitations of geostatistical approaches that require stationarity and volumetric importance of stratigraphic features are bypassed by representing heterogeneity through surface-based models. As a result, the models capture the fine-scale features that control connectivity.

These methods were applied at a Wilcox asset located in more than 4000 feet of water in northwest Keathley Canyon, GoM. The target intervals exhibit a shift from deposition in unconfined fans to weakly confined channels, to channel-levee environments, each with their own distinct and hierarchical heterogeneities (e.g., facies distribution, shale drapes). Well data were analyzed within depositional context and calibrated to well-studied deep-water outcrop analogs. Quantitative outcrop and subsurface inputs were used to constrain the PM models and ensure that the heterogeneity observed in the wells was appropriately modeled away from well control. Analysis of these models reveals robust representations of deep-water heterogeneities and highlights the importance of surface-based approaches for capturing reservoir heterogeneity and forecasting performance. ■

Biographical Sketches

Laura Murray has over 21-years of experience with Chevron, specializing in reservoir characterization of development, appraisal and major capital projects. She graduated from the University of Wyoming with a MS in Geophysics and Western Washington University with a BS in Geology, specializing in Geological Engineering. She has worked a variety of depositional settings in different basins, characterizing many complex reservoir systems (brownfield, greenfield & exploration) both domestic onshore and offshore, as well as internationally. The last 15 years Laura has used her geologic knowledge and expertise developing detailed reservoir characterizations and building static reservoir models in the Deepwater Gulf of Mexico and onshore Midcontinent Permian, Uinta and San Juan Basins. She has experience with clastic/aeolian, carbonate and mixed systems – both conventional and unconventional, in addition to primary, secondary and tertiary recovery expertise.

Her roles have included development, appraisal & operations geologist, appraisal geophysicist, earth science team lead, earth science advisor, static modeler, and her current role as Gulf of Mexico Appraisal Static Modeling Advisor. Laura is also the Founder of The Rescue for PTSD, a nonprofit organization that adopts rescue/shelter dogs and trains them to be service dogs for military Veterans suffering with PTSD.



Fabien Laugier has 5-years of experience with Chevron Energy Technology Company, specializing in Deepwater stratigraphy and reservoir modeling, and quantitative characterization of reservoir heterogeneity and connectivity across multiple asset types. He graduated from the Colorado School of Mines with a Ph.D. in Stratigraphy where he focused on shelf-edge to Deepwater deposits in the Karoo Basin of South Africa, and previously attained a BS in Geology and BA in Business/Economics from Wheaton College, Illinois.

As part of the Chevron ETC Clastic Stratigraphy team Fabien works primarily as a research scientist focused on predicting reservoir heterogeneity, connectivity, and performance for all clastic and unconventional assets. Additionally, he is a technical consultant on international and domestic projects ranging from deep-water to aeolian, and is the project manager for machine-assisted stratigraphic characterization R&D.

Prior to Chevron Fabien interned and consulted with multiple major and independent oil and gas companies, focusing on deep-water and unconventional exploration and reservoir characterization. He has a significant field stratigraphy background, having spent over 400 days in the field in 15 countries, and leverages this expertise for understanding the fine-scale heterogeneity that impacts performance, which is often missed by subsurface sampling.