RMAG ROCKY MOUNTAIN ASSOCIATION OF GEOLOGISTS

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ABSTRACTS

8:00 AM	**The Mowry Shale of the Powder River Basin: Interpretation and Evaluation of a Mudrock Reservoir in a Sequence Stratigraphic Framework**
Presenter	Jeffrey May, Geologic Consultant & Colorado School of Mines
Additional Authors	Alexa L. Socianu and Stephen A. Sonnenberg, Colorado School of Mines
Abstract	The Mowry Shale is a prolific source rock in numerous Laramide basins and an actively targeted unconventional reservoir in the Powder River Basin. It comprises recrystallized radiolaria, fish debris, marine kerogen, terrigenous silt and clay, and volcanic ash. Interpreting and evaluating this formation in a sequence stratigraphic framework helps understand lithologic heterogeneity and the controls on reservoir quality. Ultimately, this framework aids in defining and mapping the optimum horizontal target. Samples from seven Mowry cores document variations in source rock, mineralogic, and petrophysical properties. Five mudstone facies can be related to variations in reservoir quality. Siltier facies exhibit elevated porosity and permeability relative to more biosiliceous facies, but lower hydrocarbon saturations and lower TOC. Additionally, thermal maturity has a major influence on critical reservoir attributes. Elevated maturity is associated with decreased mixed-layer clay (illite/smectite) content, lower water saturations, and higher permeabilities. The Mowry can be subdivided into a succession of parasequences, which in turn, stack to form upward coarsening regressive packages interpreted as highstand systems tracts (HSTs). Three HSTs make up the Mowry Shale. The middle Mowry HST exhibits the greatest proportion of biosiliceous facies and highest TOC and hydrocarbon saturations. Peak reservoir quality occurs in the uppermost parasequences of this HST, where detrital silt content, moveable hydrocarbons, and mechanical properties are enhanced. Although apparently the best horizontal target, placing wellbores slightly lower allows for hydraulically stimulating a thicker reservoir section with upward growth into this optimal interval.

Well performance also depends on completion techniques and spacing. Selective targeting in thermally mature areas with longer laterals and fracking with higher proppant intensity results in year-over-year production increases on a per-foot basis and cost reductions comparable to some of the best U.S. shale plays. However, parent-child effects are beginning to challenge this low-permeability play.

Presenter Biography

Jeff received his B.A. in Geology from Earlham College, M.S. in Geology from Duke University, and Ph.D. in Geology from Rice University. He has worked in the oil and gas industry for 45 years: as a research geologist with Marathon Oil Company (1981-1994); as a geological and geophysical consultant with Enron Oil & Gas (1994-1996) and GeoQuest Reservoir Technologies (1996-1998); as an exploration geoscientist with DDD Energy (1998-2001); and with EOG Resources beginning in 2001, first as Chief Stratigrapher and then as Chief Geologist, until his retirement in 2011. He now is a geologic consultant and an Affiliate Faculty member in the Department of Geology and Geological Engineering at Colorado School of Mines.

Jeff has conducted sedimentologic, sequence stratigraphic, and seismic stratigraphic projects on basins and fields worldwide. Areas of expertise include onshore and offshore Gulf of Mexico; onshore and offshore California; Uinta, Green River, Washakie, Denver, Powder River, Permian, and Williston Basins; northern and eastern Egypt; and Natuna Sea, Indonesia. He also leads a variety of classroom and field seminars on clastic facies, deep-water sandstones, sequence stratigraphy, and mudrock deposition and stratigraphy, most notably for the American Association of Petroleum Geologists, the Petroleum Technology Transfer Council, Nautilus Worldwide, many oil and gas companies, and universities. His publications encompass numerous papers and abstracts on deep-water sandstones, sequence stratigraphy, geophysical interpretation, and mudrock deposition. Jeff has twice been presented the best luncheon speaker award by the Rocky Mountain Association of Geologists, was presented the Frank Kottlowski award for best speaker in the Energy Minerals Division at the AAPG annual convention in 2012, completed an AAPG Distinguished Lecture tour, and received the Outstanding Scientist Award from RMAG in 2017 and the Distinguished Service Award from RMAG in 2024.

8:30 AM	Proximal-to-Distal Facies Trends and Laramide Tectonic influence in the Mowry Shale, Greater Green River Basin, Wyoming
Presenter	Brent Greenhalgh, Wexpro Company
Abstract	The Mowry Shale is an emerging unconventional resource play in the Powder River Basin (PRB), where recent drilling has demonstrated commercial oil and gas production despite challenges posed by bentonitic ash beds. Although the Mowry is stratigraphically continuous into the Greater Green River Basin (GGRB), the interval remains lightly explored there. New high-resolution data from a complete core through the Mowry Shale in southwest Wyoming and two detailed measured sections along the northern flank of the Uinta Mountains in Utah significantly improve stratigraphic understanding in the GGRB. A regional west-to-east cross section documents pronounced stratigraphic thinning toward the Uinta Mountains, indicating that the Uinta uplift was active during Mowry deposition and influenced accommodation. The core-outcrop transect, oriented roughly parallel to published depositional dip, reveals systematic west-to-east facies changes. The westernmost section is characterized by high detrital silt content and low fossil abundance (scattered fish scales and minor inoceramids). The middle section contains the highest clay content and lowest biosiliceous content. The easternmost section is dominated by silica-rich mudrocks with abundant inoceramid and radiolarian fossils and the lowest clay content. This progression records an eastward decrease in terrigenous (deltaic) influence and a corresponding increase in open-marine, biosiliceous sedimentation. These observations provide a predictive framework for comparing the Mowry Shale in the GGRB to the PRB and identifying the most prospective unconventional targets in the GGRB
Presenter Biography	Wexpro Company geology supervisor, worked the Green River Basin for almost 20 years

9:00 AM	Depositional Trends in the Mowry Formation and Implications for Unconventional Play Elements
Presenter	Mark Nell, Wexpro Company
Additional Authors	Dr. Zane Jobe, Colorado School of Mines

Abstract The Mowry Formation is a prolific unconventional reservoir in the Powder River Basin but remains largely untested in the Green River Basin (GRB). Previous depositional models have generally interpreted the Mowry in the GRB as having less unconventional potential because of greater siliciclastic input and bottom-water circulation associated with west-to-east sediment transport from the Sevier orogenic belt. This study integrates regional stratigraphic correlations, well-log interpretation, core analysis, geochemistry, and new X-ray fluorescence (XRF) analyses to develop a basin-scale depositional framework for the Mowry Formation. Preliminary elemental proxies for redox conditions, clastic dilution, and silica provenance define regionally consistent geochemical domains that support an alternative paleogeographic interpretation, characterized by depositional trends extending northwest-southeast through the Green River and southern Wind River Basin. Within this framework, productive areas of the Powder River Basin and significant portions of the Green River Basin occupy comparable depositional settings, suggesting regional continuity of the geologic conditions favorable for unconventional reservoir development.

Presenter Biography Mark is closing in on 20 years exploring for oil and gas. he has a broad background in technical skills, but strives to be an integrator above all.

10:00 AM — New Stratigraphic and Geochemical insights into the Mowry Shale in the Powder River Basin, Wyoming and Montana, USA

Presenter Jane Hearon, U.S. Geological Survey

Additional Authors Katherine L. French - U.S. Geological Survey, Denver, CO

Abstract The Cretaceous Mowry Shale in the Powder River Basin (PRB) of Wyoming and Montana is an emerging unconventional (continuous) resource, yet its stratigraphic architecture, geochemical heterogeneity, and burial history remain poorly characterized—gaps that hinder prediction of petroleum phase, source rock quality, and producibility. The Mowry consists of laminated, organic-rich, siliceous sediments deposited in a shallow epicontinental sea. Here we integrate regional subsurface mapping of stratigraphy and pressure with geochemical and geomechanical data from six Mowry cores in the PRB spanning proximal to distal marine settings and a range of thermal maturities. We mapped stratigraphy in 3,700 well

logs, compiled mud weight data from 350 wells, and analyzed over 1,200 feet of core, acquiring TOC, programmed temperature pyrolysis, ICP-OES/MS, and Leeb Hardness data.

We divided the Mowry into three informal units—upper, middle, and lower—within a sequence stratigraphic framework. Total thickness decreases from approximately 325 feet in the northwest PRB to 125 feet in the southeast. Hardness correlates positively with Si and negatively with Al, suggesting silica and clay contents as first-order controls on rock strength with implications for completion and fracability. The upper and middle Mowry contain the highest total Si, while the middle and lower Mowry are enriched in TOC and redox-sensitive trace elements.

Critically, simple depth trends do not explain thermal maturity within the basin. Tmax data reveal elevated thermal maturity aligned with, but shallower than, the present-day synclinal axis, coinciding with zones of higher pressure calculated from mud weights. We interpret this trend as preserving deeper burial along the eastern basin limb, subsequently uplifted by Laramide tectonics in the Black Hills region. This burial history, rather than present-day depth, governs petroleum phase and composition across the basin.

Presenter Biography

Jane Hearon is a geologist with the U.S. Geological Survey in Denver, Colorado. She currently conducts regional-scale research and resource assessments on both petroleum systems and geologic hydrogen. She holds degrees from Cornell University (BA) and Colorado School of Mines (MS and PhD).

10:30 AM — Delineating Silica Sources in Cretaceous Marine Sedimentary Systems

Presenter Katherine French, US Geological Survey

Additional Authors Jane S. Hearon, USGS, Jason A. Flaum, USGS, Justin E. Birdwell, USGS, Richard O. Lease, USGS, Katherine J. Whidden, USGS

Abstract

Identifying biogenic silica in marine sedimentary systems provides insights into paleoproductivity, paleoenvironments, sequence stratigraphy, and geomechanical properties, but identifying biogenic silica requires distinguishing it from additional sources. The Mowry Shale, for example, highlights that biogenic silica can co-occur with a detrital sand and silt fraction. Recently, the Si-Zr cross-plot was used to identify biogenic silica in the Mowry Shale of the Wind River Basin, but those results showed that additional influences and possible limitations of this proxy required examination. Towards this aim, this presentation will evaluate Si-Zr relationships across diverse depositional settings of the Cretaceous Western Interior Seaway (WIS). The data consist of 2,750 samples, including bentonites, analyzed by inductively coupled plasma optical emission spectroscopy and mass spectrometry (ICP-OES/MS) from 15 drill cores and one outcrop spanning Aptian–Maastrichtian strata from Texas to Alaska. The results reveal that lithofacies and depositional processes significantly influence Si-Zr relationships. The Si-Zr cross-plot often effectively distinguishes biogenic silica from other sources, but abiotic silica can sometimes occur within the biogenic trend. The results indicate that Arctic-sourced waters in the northern regions of the WIS favored radiolarians and siliceous mudstone deposition, whereas Tethyan-sourced waters in the southern regions of the WIS favored calcareous plankton and deposition of calcareous lithologies. The results further show that Zr and Hf better separate biogenic from detrital silica than other detrital-associated elements (e.g., Al, Ti). Finally, the Si-Zr cross-plot preserves proximal to distal relationships that correspond to source rock quality and metal enrichment with likely additional applications to sequence stratigraphic interpretations. Collectively, these results refine the Si-Zr proxy, thereby improving understanding of silica sources in sedimentary systems, while also revealing additional information embedded in the Si-Zr cross-plot. This presentation will present these new insights, while also highlighting their application to the Mowry Shale of the Wind River and Powder River basins.

Presenter Biography

Katherine French is a research geochemist at the US Geological Survey in Denver, CO. She specializes in sedimentary geochemistry, including source rock characterization.

11:30 AM — Field and Geochemical Laboratory Criteria for Evaluating and Collecting Unweathered Outcrop Samples of Mowry Shale

Presenter

Michael Lewan, Lewan GeoConsulting Corp

Abstract

When subsurface cores and well cuttings are available they are typically preferred to identify potential source rocks of a petroleum system, but they as well have their issues with regards to storage conditions and thermal maturity effects. Marginal outcrops outlining a petroleum system still and traditionally provide a source

of thermally immature samples that can be placed within the stratigraphic and regional context of a petroleum system to predict their effectiveness in the subsurface. However, previous published geochemical data has shown that outcrop weathering of source rocks can severely be adulterated resulting in potential source rocks not being recognized or not being correctly interpreted with respect to their actual quality and thermal maturity. Although previous published papers on the adverse effects of outcrop weathering of source rocks have documented the adverse affects of weathering on identifying and interpreting the full potential of a source rock are informative and noteworthy, they fail to provide good field data and observations to evaluate types and extent of outcrop weathering for geologists and geochemists collecting source rock samples. Examination of more than 300 outcrops of petroleum source rocks and black shales globally over 46 years in various climatic regimes indicates there are two prominent styles of outcrop weathering; 1) face weathering and 2) pedogenic weathering. Face weathering, as its name implies occurs on the face of an outcrop and propagates laterally perpendicular inward from the outcrop face as a result of physical weathering and the development of an outermost fissile zone. Conversely, pedogenic weather propagates downward from the source rock above its surface and is akin to soil formation as a result of chemical weathering and the development of a leached discolored saprolite horizon. Here examples of both types of weathering of the Mowry Shale source rocks are presented with respect to field observations and geochemical data at the Steinaker outcrop where both types of weathering occur. The objective being to provide petroleum geologists and geochemists field criteria for collecting unweathered outcrop samples representative of their full potential of a source rock with examples of other weathering sites (e.g., Monterey, Kreyenhagen, Eagle Ford/Boquillas, Chattanooga, and Woodford) .

Presenter Biography

Michael D. Lewan, has 50+ years of experience in the petroleum industry that started with his employment with Shell oil Company in their New Orleans exploration and production Gulf Coast office as a geologist and geochemist, with Amoco Production Company Research Center in Tulsa as a research geochemist and geologist, and with the U.S. Geological Survey (Denver Federal Center as a research geochemist. During this time, he served as the Project Chief of the USGS Petroleum Processes Research Project, and also served as an Adjunct Professor at the Colorado School of Mines in the department of Geology and geological Engineering for 11 years as a graduate adviser, committee member, and collaborative researcher. He has 13 years prior experience with Amoco Production Company as a research scientist in their Tulsa Research Center and 3 years prior experience with Shell Oil Company as an exploration geologist/geochemist in their New Orleans Offshore Exploration & Production Office. He has pioneered the development of hydrous pyrolysis in simulating natural petroleum formation, which has been used to evaluate expulsion, kinetic parameters, thermal maturity indices, and quality of petroleum formed from various source rocks containing different types of organic matter and mineral matrices. He is currently principal of Lewan GeoConsulting Corporation (Lakewood, CO) in offering consultation on petroleum systems and source rock characterization. Michael is the recipient of the 2015 AAPG Robert Berg Outstanding Research Award, 2014 Rocky Mountain Association of Geologists Outstanding Scientist Award, 2004 Rocky Mountain Association of Geologists Best Paper Award, AAPG 1991-1992 Distinguished Lecturer, AAPG 1991 George C. Matson Memorial Best Oral Presentation Award, 1986 Organic Geochemistry Division of the Geochemical Society Best Paper Award, and U.S. Department of Interior 2004 Meritorious Service Award for Scientific Excellence. He received his Ph.D. from the University of Cincinnati, M.S. from Michigan Technology University, and B.S. from Northern Illinois University.

11:30 AM	**Geochemical Insights from Low-Temperature Hydrous Pyrolysis using Mowry Shale Core Samples from the Powder River Basin, Wyoming**
Presenter	Alexa Socianu, Colorado School of Mines
Additional Authors	Michael Lewan, Lewan GeoConsulting, Paul Hackley, USGS
Abstract	This study leverages a relatively new laboratory approach of low-temperature hydrous pyrolysis (LTHP) to assess the quantity and quality of liquid hydrocarbons present in two thermally mature Mowry Shale cores from the Powder River Basin (PRB). Additionally, two produced oils from conventional and unconventional Mowry wells in the PRB were analyzed to compare experimental results with compositions observed from naturally produced oils. The LTHP method exposes crushed core material to liquid water at 300°C for 24 hours, which releases pre-existing oil trapped within the sample pore network for measurement. Vitrinite reflectance from the core samples used in these experiments ranged from 0.81-

1.12% VRo, and did not change post-experiment, indicating that the method does not modify the apparent thermal maturity. The LTHP experiments found a hydrocarbon concentration of 0.98-1.14 mg oil/g rock. The geochemical signature of post-LTHP core samples and released oils suggests that the experimental conditions liberated pre-existing oil from the sample without the addition of oil from any newly converted kerogen. Released oils from the LTHP experiments were compositionally similar to the two naturally produced Mowry oil samples. The Mowry

Shale samples used in this research were cored over a decade ago, implying that the LTHP method is a viable approach useful for predicting produced oil properties of newly developing source-rock plays when produced oil samples may be scarce but stored core is available.

Presenter Biography	Alexa Socianu earned her B.A. from Northwestern University in Biology and Geology and her M.S. from the University of Wyoming in Geology where she first began her research on the Mowry Shale. She is currently finishing her Ph.D. at Colorado School of Mines with a focus on sedimentology, stratigraphy, and pore-scale features of mudrocks. Alexa has worked in the oil and gas industry as a senior geoscientist for over a decade with experience in Rockies, Midcontinent, and Permian basins.

1:00 PM	**Nanoconfined Hydrocarbon Phase Behavior and Pore Criticality in Mowry Shale: Implications for Unconventional Reservoir Evaluation**
Presenter	Ephraim Kakra Owusu-Banahene, University of Wyoming
Additional Authors	Morteza Dejam, University of Wyoming, Hertanto Adidharma, University of Wyoming
Abstract	Unconventional reservoirs such as Mowry Shale contain hydrocarbons within complex nanoporous organic- and mineral-associated pore networks, where phase behavior can differ substantially from bulk fluid predictions used in conventional reservoir engineering. These confinement effects directly influence hydrocarbon storage, saturation conditions, fluid mobility, and production forecasting. In this study, adsorption-desorption and differential scanning calorimetry (DSC) experiments are performed to investigate the phase behavior of propane, used as a model

hydrocarbon fluid, confined in Mowry Shale. While these methods have been widely applied to synthetic nanoporous materials, their application to natural shale systems remains limited due to mineralogical heterogeneity, broad pore-size distribution, and complex fluid-rock interaction.

The Mowry Shale sample was characterized using nitrogen adsorption at 77 K and Brunauer-Emmett-Teller (BET) analysis. The resulting isotherm exhibited an H3-type hysteresis loop, indicating the presence of slit-shaped nanopores commonly associated with clay- and organic-rich shale matrices. Capillary evaporation conditions obtained independently from adsorption-desorption measurements and DSC thermograms showed close agreement, demonstrating that both methods can reliably capture confined fluid phase transitions in natural nanoporous reservoir rock. The experimentally measured capillary evaporation data were further analyzed using the three-line approach to determine the pore critical point (PCP) of propane confined in Mowry Shale. This represents the first experimental determination of a hydrocarbon PCP in Mowry Shale. The measured PCP departs from trends previously reported for pure hydrocarbons confined in synthetic nanoporous materials. The PCP was then incorporated into a Peng-Robinson equation-of-state (EOS) framework to model the phase transition conditions of the nanoconfined fluid. The resulting EOS model accurately reproduces the full capillary evaporation curve, providing a practical route for incorporating nanopore confinement effects into reservoir fluid characterization. Improved understanding of nanoconfined hydrocarbon phase behavior can support better estimates of in-place volumes, phase transition pressures, producible hydrocarbon fractions, and reservoir simulation inputs for Mowry Shale development.

Presenter Biography

Ephraim Kakra Owusu-Banahene is a PhD candidate in the Department of Energy and Petroleum Engineering at the University of Wyoming, advised by Dr. Morteza Dejam. His research focuses on the study of phase transitions, pore criticality, and composition variation of hydrocarbon components confined in synthetic nanoporous materials and natural shale. His work combines adsorption-desorption and differential scanning calorimetry experimentation, pore characterization, and equation-of-state modeling to investigate how nanoscale confinement alters hydrocarbon phase behavior. He has contributed to peer-reviewed publications in reputable journals in the area of confined fluid phase behavior in nanoporous media. His current research examines single and multicomponent hydrocarbon systems in Mowry Shale, with the goal of improving confined fluid characterization for reservoir evaluation, fluid-in-place estimation, and production forecasting.

1:30:00 PM	Interpretable Pressure-dependent Permeability Modeling for Mowry Shale
Presenter	Nijat Rustamov, University of Wyoming
Additional Authors	Saman A. Aryana, University of Wyoming
Abstract	Emerging interest in shale gas exploration is driven by technological advances that enable numerical and experimental investigation of fluid transport in confined, micro-porous media, with potential implications for natural gas production and for carbon dioxide and hydrogen storage. In this work, we investigate the numerical aspects of modeling gas transport in confined, complex porous media and move beyond the classical assumption of bulk-fluid behavior. We incorporate gas slippage and Knudsen diffusion into our modeling approach and develop scalable techniques that accurately capture micro-flow physics. Using this model, we conduct an ensemble of over 5,000 two-dimensional simulations on synthetically generated porous media spanning the slip and transitional flow regimes characteristic of shales and tight systems. From this dataset we extract physically interpretable morphological and network-theoretic properties and apply white-box symbolic regression to develop an empirical permeability model. These relationships outperform established closed-form correlations such as Kozeny-Carman and are comparable in accuracy to black-box machine learning models, with the added benefit of physical interpretability. We further show that Klinkenberg-type slip corrections yield non-physical coefficients when fitted across the full Knudsen range, and propose a flexible power-law Knudsen correction, coupled with the symbolic-regression model, to predict pressure-dependent apparent permeability. This closed-form model is then applied end-to-end to a high-resolution, SEM-imaged Mowry Shale sample -- an unseen, out-of-distribution real shale -- as a first test of whether the functional form transfers beyond the training distribution, recovering the directly simulated apparent permeability within a typical factor of 1.8 across three orders of magnitude in pressure.

Presenter Biography	Nijat Rustamov is a PhD candidate in Chemical Engineering at the University of Wyoming, defending in September 2026. His research focuses on gas transport in confined, micro-porous media, spanning numerical modeling, high-performance computing, and machine learning. The objective of his dissertation is to enable fast, scalable prediction of transport properties in shales and tight systems, at engineering accuracy, using both direct numerical simulation and surrogate models.

2:00:00 PM	**Permeability Evolution in Mowry Shale: Experimental Investigation of Stress Sensitivity, Gas Slippage, and Flow Regime Transition**
Presenter	Ifeanyi Valerian Nwankwo, University of Wyoming
Additional Authors	Morteza Dejam, University of Wyoming

Abstract

Mowry Shale is an emerging unconventional reservoir with considerable hydrocarbon potential; however, its permeability evolution under varying stress conditions remains poorly understood. Reliable prediction of production performance requires a quantitative understanding of the coupled effects of pore pressure, confining pressure, and gas slippage on fluid transport. Nevertheless, such studies for Mowry Shale are currently lacking. The current work addresses the first systematic experimental investigation of the coupled mechanisms using intact cylindrical Mowry Shale outcrop samples. Nitrogen adsorption (BET/N_2) and micro-computed tomography (micro-CT) analyses indicated a multiscale pore system consisting of nanopores with an average diameter of 3.83 nm and larger pores averaging 0.68 μm. Steady-state nitrogen permeability measurements were conducted under constant confining pressures of 15, 25, and 35 MPa to simulate low, intermediate, and high reservoir stress conditions.

The results reveal that during depressurization, permeability evolution is controlled by a transition from stress-dominated flow at higher pore pressures to gas slippage-dominated flow. Pronounced permeability hysteresis was observed during loading and unloading, indicating irreversible pore structure deformation and significant stress sensitivity. Apparent permeability increased by up to 96% during depressurization, while gas slippage contributed more than 70% of the measured permeability under high effective stress

conditions. Evaluation of the Klinkenberg effect correction further revealed that the first-order model becomes unreliable at low effective stress, as evidenced by negative intrinsic permeability intercepts, highlighting the need for improved permeability correction models for ultra-tight shale reservoirs.

The findings provide new insight into the stress-flow behavior of Mowry Shale and establish an experimental benchmark for stress-dependent permeability modeling. The outcomes have important implications for reservoir characterization, production forecasting, hydraulic fracturing design, and building more reliable digital and numerical models for Mowry Shale development.

Presenter Biography

Ifeanyi Valerian Nwankwo is a Ph.D. candidate in the Department of Energy and Petroleum Engineering at the University of Wyoming, where he conducts research under the supervision of Dr. Morteza Dejam. He focuses on understanding the coupled flow and geomechanical behavior of Lower Cretaceous Mowry Shale in Powder River Basin. Ifeanyi combines laboratory experiments with petrophysical analysis, rock physics, geomechanics, and advanced pore-scale characterization to investigate how stress influences pore structure, permeability evolution, and fluid flow in unconventional shale reservoirs. He aims towards improving reservoir characterization and providing a stronger foundation for predicting production performance and optimizing reservoir management. His broader research interests include unconventional reservoir characterization, digital rock technology, geomechanics, underground gas storage, and data-driven approaches for subsurface energy applications.

3:00:00 PM — Influence of Drilling and Stimulation Fluids on the Mechanical Behavior of Mowry Shale

Presenter Kam Ng, University of Wyoming

Additional Authors Ehsan Dabbaghi, Johanna Romero and Vladimir Alvarado - University of Wyoming

Abstract

Shale formations have become increasingly important for hydrocarbon production because advances in horizontal drilling and hydraulic fracturing have enabled the economic recovery of previously inaccessible resources. Mowry Shale is one of the principal Cretaceous petroleum source rocks in the northern Rocky

	Mountains. However, its geomechanical response to drilling and stimulation fluids has not been thoroughly understood. This study investigates the influence of these fluids on the mechanical behavior of the Mowry Shale. Core material from well S505 in Wyoming, archived by the United States Geological Survey, was used to prepare nine cylindrical specimens (12.5 mm diameter × 25 mm height). Three specimens were exposed to synthetic brine for 35 days, three were treated with brine for 21 days followed by drilling fluid for 14 days, and three were treated with brine for 21 days, drilling fluid for 14 days, and stimulation fluid for an additional 14 days. Triaxial compression tests were conducted using a GCTS RTR-1500 system at 96 °C with a pore pressure of 9 MPa and confining pressures of 12, 26, and 40 MPa. Exposure to drilling fluid increased both compressive strength and Young's modulus compared with brine-treated specimens, while subsequent exposure to stimulation fluid produced a further increase in these properties. These findings provide new experimental data on fluid-induced changes in the mechanical behavior of the Mowry Shale and contribute to a better understanding of shale integrity during drilling and hydraulic fracturing operations.
Presenter Biography	Dr. Kam Ng is a Professor at the Department of Civil and Architectural Engineering and Construction Management at the University of Wyoming. His research focuses on transportation and energy geotechnics, and innovative construction materials. He has mentored two postdocs, 9 Ph.D. students and 28 MS students. He has published more than 110 peer-reviewed journal papers, received more than 14 millions in research funding, and filed over 20 patents. He received several awards from national organizations and University of Wyoming. He is currently the President's Innovation Fellow, Hoy Engineering fellow, and HT Person Faculty Fellow.

3:30:00 PM	**Drilling the Bentonite-Bearing Mowry Shale: Engineering Swelling Inhibition and Drilling-Fluid Formulation**
Presenter	Tawfik Elshehabi, PhD, PE, University of Wyoming
Additional Authors	Tate Novodvorsky, University of Wyoming, Paden Knull, University of Wyoming, Joe Hajba, University of Wyoming
Abstract	Bentonite beds are distinctive stratigraphic markers in the Mowry Shale. During drilling, aqueous fluids can hydrate and disperse

these reactive clays, destabilize the wellbore, and introduce ultrafine solids that alter drilling-fluid and formation properties. This exposure may also modify the near-wellbore native rock wettability state, which can influence subsequent stimulation, flowback, and production. This study quantified swelling kinetics in Mowry shale and Wyoming bentonite and evaluated a framework that couples salt inhibition with mud performance. Compacted wafers prepared from Mowry shale and Wyoming sodium bentonite, used as a high-reactivity reference, were exposed for 72 h to a barite-weighted polymer water-based drilling fluid containing 1–10 wt% NaCl, KCl, $CaCl_2$, or NH_4Cl. A dynamic linear swell meter recorded confined axial expansion. Hyperbolic and single- and multi-term exponential equations were fitted to the measured swelling curves. American Petroleum Institute rotational viscometer and filtration tests evaluated drilling fluid performance.

In the uninhibited fluid, bentonite expanded by more than 90% after 72 h, and half of this expansion occurred within the first 9 h. Both bentonite and Mowry shale showed clear salt- and concentration-dependent responses. The lowest swelling within the tested ranges occurred at 6 wt% KCl, 7 wt% NaCl, 10 wt% $CaCl_2$, and 8 wt% NH_4Cl. Among these formulations, 6 wt% KCl delivered the strongest combined performance by minimizing swelling while best preserving rheology. The response shows that effective inhibition requires more than salinity alone; it must account for cation exchange, electrolyte concentration, smectite hydration, and polymer–brine compatibility. A single-term exponential model captured both swelling trajectories with R^2 values of 0.97–0.99. Fitting only the first 5 h showed potential to project the 72 h response and reduce measurement time by 93%. This workflow advances the Mowry fluid formulation from salt screening to an integrated clay–fluid design that protects the wellbore and lays the foundation for effective stimulation, flowback, and production.

Presenter Biography

Dr. Tawfik Elshehabi is an Assistant Professor of Energy and Petroleum Engineering at the University of Wyoming. He is a licensed Professional Engineer in Wyoming and the Principal Investigator of the Drilling Innovation Group at UW. He directs the state-of-the-art Drilling and Completions Simulation Facility. Dr. Elshehabi holds a PhD in Petroleum and Natural Gas Engineering from West Virginia University. He serves as the Director of the Undergraduate Program, ABET Accreditation Coordinator, and

External ABET Evaluator, promoting excellence in engineering education. He develops environmentally friendly drilling/completion fluids and cement for oil & gas, geothermal, and carbon storage drilling applications. His work integrates advanced laboratory characterization with machine learning and digital twins to enhance automation and support energy goals. Dr. Elshehabi advocates for energy integration, where drilling remains the key enabler of subsurface resources development.

4:00:00 PM	**Dud or Future Stud? A Geological Comparison of the Mowry Formation in the Bighorn and Powder River Basins**
Presenter	Laura Johnson, Anschutz Exploration Corporation
Abstract	The siliceous, organic-rich shale of the Mowry Formation has emerged as one of the premier unconventional reservoirs in the Powder River Basin, yet exploration efforts in the adjacent Bighorn Basin failed to establish line of sight to commercial development during the early 2010s. This presentation compares the geology and subsurface characteristics of the Mowry Formation across the two basins to evaluate the geologic factors that differentiate a successful unconventional play from one that remains unproven. The presentation begins with a regional geologic and petroleum systems overview before comparing depositional setting, stratigraphy, source rock quality, thermal maturity, reservoir quality, pressure regime, and other key subsurface parameters that influence unconventional reservoir performance. Although deposited in a more proximal setting, the Bighorn Basin Mowry retains source rock quality comparable to that of the Powder River Basin. However, significant differences in reservoir pressure, porosity, and reservoir quality, driven by regional geologic variations, distinguish the two systems and provide important context for understanding their contrasting exploration outcomes. Exploration programs by POGO, Resolute, and Cirque in the Bighorn Basin are reviewed and contrasted with the subsequent emergence of the Powder River Basin as a major Mowry resource play. While drilling, completion, and production practices have evolved considerably since the Bighorn Basin was last evaluated nearly 15 years ago, the primary emphasis of this presentation is on the geologic controls governing reservoir performance. By integrating regional geology with subsurface characterization, this comparison provides a framework for evaluating the remaining exploration

potential of the Bighorn Basin Mowry and poses the question: Is Bighorn Basin Mowry a geologic dead end, or an overlooked opportunity?

Presenter Biography	Laura Johnson is a Subsurface Manager of Utah, Colorado, and New Ventures at Anschutz Exploration Corporation and a Colorado School of Mines graduate who has spent her career exploring the geology of the Rocky Mountains. With experience spanning multiple conventional and unconventional resource plays in the US, she is driven by a passion for understanding the subsurface, integrating diverse datasets, and discovering what others have overlooked. Laura is equally passionate about working with talented, collaborative teams, believing that the best technical solutions come from bringing together diverse perspectives and expertise. Whether evaluating new ventures or optimizing existing assets, she approaches every challenge with the curiosity, creativity, and mindset of an explorer.
4:30:00 PM	**Estimating the Economic Returns and Regional Impacts of Improved Resource Recovery Through Integrated Drilling and Production Forecasting**
Presenter	Timothy J. Considine, University of Wyoming
Additional Authors	Maryam Lakjaa, School of Energy Resources, University of Wyoming
Abstract	This study develops an integrated framework for forecasting unconventional oil and gas production in Wyoming, with particular emphasis on the Powder River Basin and the relatively understudied Mowry Shale. The framework combines decline curve analysis (DCA), artificial neural networks (ANN), econometric drilling models, and regional economic impact analysis to evaluate how technological improvements affect drilling, production, and Wyoming's economy. Production data from more than 6,000 wells drilled between 1995 and 2023, comprising approximately 800,000 monthly observations, were analyzed across major unconventional reservoirs. Exponential, hyperbolic, harmonic, and hybrid hyperbolic DCA models were applied to forecast production. Integrating an ANN with the hybrid decline model improved forecasting performance by capturing both rapid initial production decline and subsequent boundary-dominated flow behavior.

An economic drilling model using Poisson regression was developed to relate drilling activity to oil and natural gas prices, exploration efficiency, technological advancement, and land ownership. Results indicate that drilling on non-federal lands is more responsive to commodity-price changes than drilling on federal lands. Forecast scenarios show that modest improvements in estimated ultimate recovery (EUR), ranging from 1% to 4%, can substantially increase future well counts and aggregate production.

The analysis further evaluates the broader economic benefits of technological advancement and public R&D investment. Projected drilling and production scenarios are used to estimate associated employment, labor income, economic output, and state and local tax revenues. By linking improvements in EUR to drilling, production, and broader economic and fiscal outcomes, the study provides a comprehensive framework for evaluating R&D investments, regulatory policies, and unconventional resource-development strategies in Wyoming.

Presenter Biography

Dr. Timothy Considine is a Professor of Energy Economics with the University of Wyoming School of Energy Resources and College of Business. He has more than 42 years of experience conducting economic analyses of the energy, mineral, and materials industries. His research focuses on petroleum markets, the economic impacts of oil and gas development, energy demand, unconventional energy technologies, and applied econometrics. He has published extensively on crude oil and natural gas markets, petroleum refining, electricity, coal, and other energy-related topics. Dr. Considine earned his B.A. from Loyola University, M.S. from Purdue University, and Ph.D. from Cornell University.