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QUARTER 4

THE RYDER SCOTT QUARTERLY

Subsurface Geologic Resource Evaluation for Unconventional Reservoirs

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Welcome Note

By: Dean Rietz, CEO

With winter and colder weather approaching and projected shortages, price spikes of heating oil, natural gas, and diesel fuel, we are reminded of the importance of a reliable and affordable domestic supply of crude oil and natural gas. As professionals in the industry, passionate about our work, it is our responsibility to inform others that, as an industry, we are committed to supply inexpensive energy to the world in an environmentally conscious manner. Along those lines, Ryder Scott has prepared a paper to explain such things as the significant difference between an estimate of original oil in place (OOIP) and proved reserves volumes to individuals such as investors new to oil and gas or media personnel (such as reporters and journalists) A condensed version of the paper is included on Page 10 of this newsletter, and the full paper will be available on our website soon.

Contact me directly at Dean_Rietz@RyderScott.com with any comments. I appreciate your feedback and enjoy conversating with you, our clients and industry friends.

Editor's Note

By: Pamela Sabo

This past quarter, Ryder Scott staff participated in events, panel discussions, and speaking engagements on topics currently relevant in the oil and gas industry. It was good to visit with clients and friends who stopped by our booth at the 2022 SPE-ATCE in Houston to talk about new trends in the industry. There was an increased interest in our new Sustainable Energy Division, as it encompasses CCUS. Page 9 of the newsletter has a short summary on this new endeavor.

"Don't settle for average. Bring your best to the moment. Then, whether it fails or succeeds, at least you know you gave all you had."
Angela Bassett

Subsurface Geologic Resource Evaluation for Unconventional Reservoirs

By: John Allen, Senior Geologist

Introduction

As oil and gas production from unconventional plays continues to drive total North American hydrocarbon production, it has become incumbent for geoscientists and engineers to develop suitable methodologies to estimate subsurface resources and reserves in these increasingly important reservoirs. For decades, geologists and engineers working in conventional reservoirs have integrated their work products into the volumetric equation to estimate both in-place and recoverable resources. While this method has been successful for conventional resources, the question remains as to its applicability to unconventional resources. The need for accurate geologic estimation of subsurface resources can become particularly apparent when considering reserves estimation for undeveloped locations that lack sufficient offset production **(Figure 1).** For this discussion, I will outline a case study that tests the applicability of the volumetric equation to unconventional resource assessment, and then discuss a petrophysical workflow that aids both geoscientists and engineers in understanding the in-place resource potential for a given asset within an unconventional play.

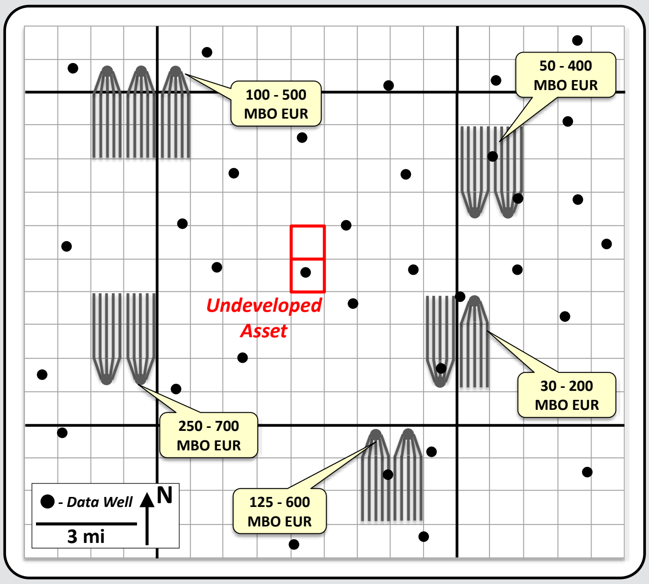


Figure 1 — Hypothetical acreage map for an undeveloped location (red sections) in an unconventional play. Note the distance to offset production and that horizontal producers in the reservoir display a variable range of EURs complicating resource estimates.

What are Unconventional Resources?

The term *unconventional resources* broadly describes those reservoirs that do not conform to the more traditional hydrocarbon plays exploited in the many decades leading up to the early 2000s. The term "unconventional" is used in place of more descriptive terms such as "tight" or "ultra-low permeability," and it can be a catch-all for an expansive set of non-traditional hydrocarbon resource types (e.g., Shale Oil/Gas, Coalbed Methane, Natural Bitumen, Gas Hydrates). It is commonly understood that reservoirs containing unconventional resources possess some, if not all, of the following characteristics:

1. Occur in predominately fine-grained rocks,
2. Low average porosities ($\phi < 10\%$),
3. Low average permeabilities ($K < 1mD$),
4. Self-sourced,
5. Vertically continuous and laterally expansive pay.

A notable feature of unconventional reservoirs is that pay is continuous and tends not to conform to more traditional trapping configurations. However, unconventional reservoirs, particularly shale oil/gas, possess storage capacity in the form of mineralogical and/or organic porosity. This observation suggests that traditional methods for resource estimation, such as the volumetric equation, should be applicable to some unconventional reservoirs (i.e., shale oil/gas).

The Volumetric Equation

$$EUR = \frac{GRV * \frac{N}{G} * \emptyset * S_{hc} * RF * CF}{FVF}$$

Equation 1 — The volumetric equation. EUR – Estimated Ultimate Recovery GRV – Gross Rock Volume; N/G – Net to Gross Ratio; ϕ – Porosity; S_{hc} – Hydrocarbon Saturation; RF – Recovery Factor; CF – Conversion Factor; FVF – Formation Volume Factor.

The volumetric equation is a static measurement of the hydrocarbon volume in the subsurface calculated via the integration of geologic and engineering parameters **(Equation 1)**. The intent of the equation is to estimate the potential volume of reserves in a reservoir based on available data (i.e., core, well logs, seismic). It was originally developed for volumetric estimation of in-place and recoverable resources in discreet, conventional traps and plays. However, the underlying principle of the volumetric equation also applies to continuous, unconventional reservoirs that a) occupy a volume of rock, b) have storage capacity (i.e., porosity), and c) part of that capacity is occupied by hydrocarbons (i.e., saturation). We developed the following case study to test the applicability of the volumetric equation to the unconventional resource estimation in shale oil/gas plays.

Case Study

To determine the applicability of the volumetric equation to unconventional resource estimation in shale oil/gas plays, a study area was selected from a producing field in an active, unconventional play **(Figure 2a)**. The goal of this case study is to compare forecasted EURs from actual horizontal producers to predicted EURs calculated from geologic and petrophysical inputs to the volumetric equation. The field covers a 35 square mile area, consists of a single reservoir interval, and contains over 40 active horizontal producers that have been online for more than two years (10+ years in some cases). EURs for these horizontal producers were forecasted in-house using decline curve analysis (DCA) software in Spotfire or tabulated from available online sources.

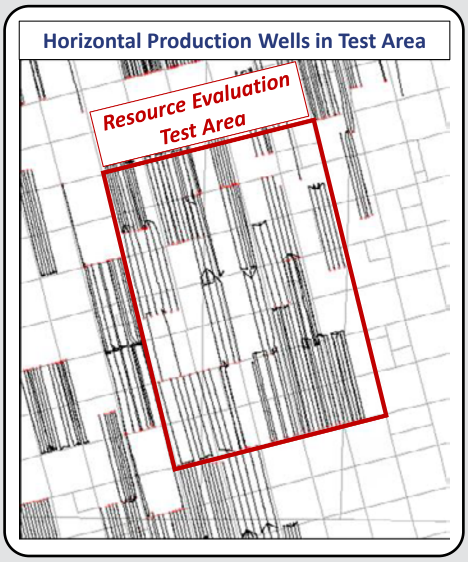


Figure 2a — Map of case study field area (Red Box; sections are one square mile) displaying the location of horizontal producers in the target reservoir.

To solve the volumetric equation, 42 vertical wells with a full suite of open-hole digital logs (i.e., GR, ResD, RhoB, PhiN, PEF) were identified within or in the region surrounding the case study field **(Figure 2b)**. Thicknesses, porosities, and hydrocarbon saturations were calculated from these open-hole digital log suites for the producing reservoir using petrophysical inputs discussed in the subsequent section. The in-place resource was determined for each well using minimum net-pay cutoffs of 4% porosity and 80% water saturation. The resultant hydrocarbon pore-volume height (HCPVH) contour map for the target reservoir of this analysis is displayed in Figure 2b.

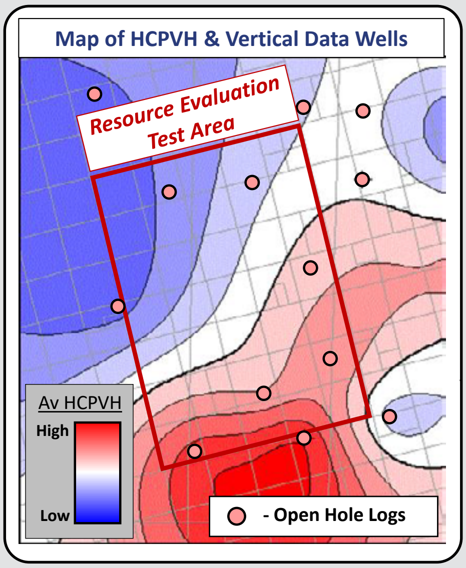


Figure 2b — Same region from Figure 2a displaying a contour map of (HCPVH) and locations of vertical wells with open-hole digital logs.

Geologic and petrophysical parameters calculated from the digital well logs were also input into Ryder Scott's proprietary stochastic simulator (STOVOL), along with appropriate ranges for drainage area and recovery factor, to probabilistically estimate EUR per well using the volumetric equation. The probabilistic EURs were then compared to the forecasted EURs from the producing horizontals **(Figure 2c)**. The graph in Figure 2d illustrates that predicted EURs from the volumetric equation are a statistical match to actual DCA forecasted EURs from the producing wells in the field, suggesting that geologic and petrophysical solutions to the volumetric equation in unconventional reservoirs can provide reasonably certain estimates for in-place volumes in shale oil/gas plays.

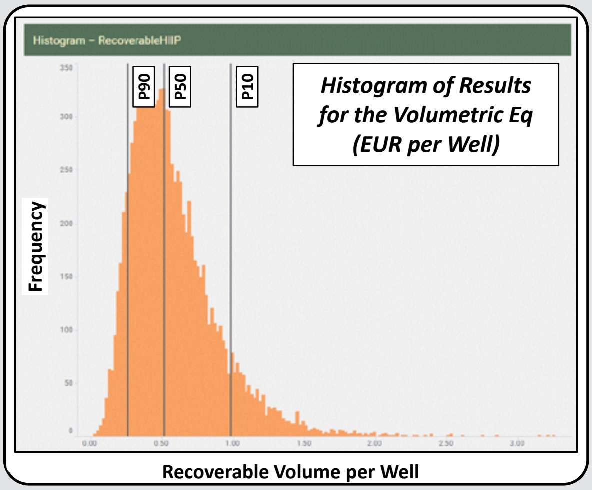


Figure 2c — Histogram of stochastic results for EUR per Well derived from STOVOL analysis of the volumetric equation for the case study area.

Application of Volumetric Equation to Reserves Estimation

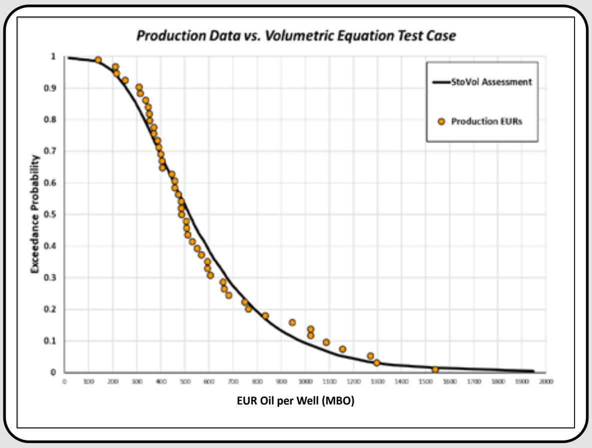


Figure 2d — Exceedance probability plot comparing the probabilistic EUR per well results (solid black line) from STOVOL to the DCA forecasted EURs for actual production horizontals in the case study field area (orange circles). The two datasets are statistically indistinguishable (Z-Score = 0.357) indicating the volumetric equation can be used to estimate resource in unconventional reservoirs.

How can geoscience contribute to resource and reserve estimation in unconventional plays, particularly for undeveloped assets where analog production is sparse? The case study above demonstrates that petrophysical inputs to the volumetric equation derived from common digital logs can reasonably assess in-place hydrocarbon volumes for some unconventional play types. The role of the geoscientist is to delineate which terms of the volumetric equation have the greater impact on in-place resource estimations in the unconventional reservoir of interest, and which petrophysical workflows provide sufficiently accurate information given the business objective(s).

The geological terms of interest in resource estimation are typically gross-rock-volume (GRV), porosity, saturation, and hydrocarbon pore-volume (a product of the first three terms).

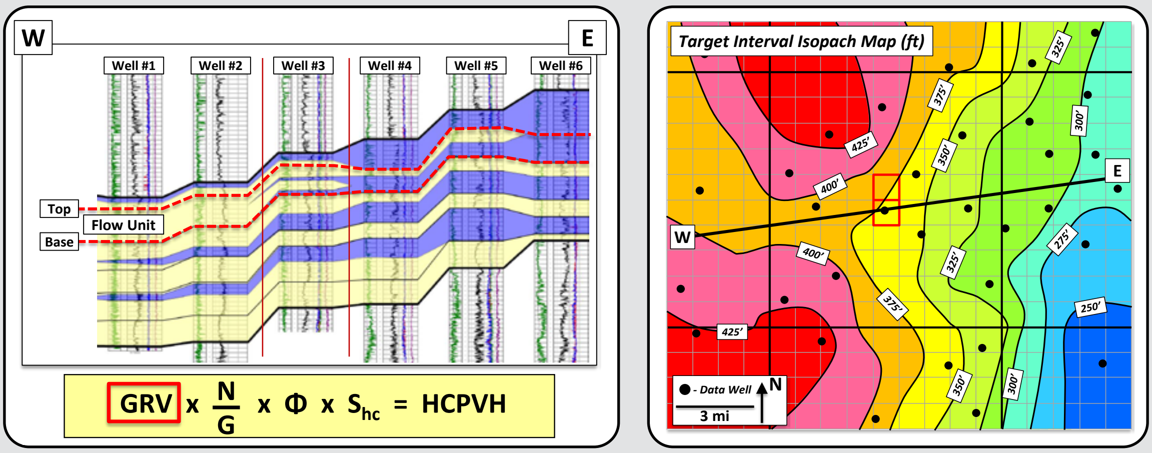
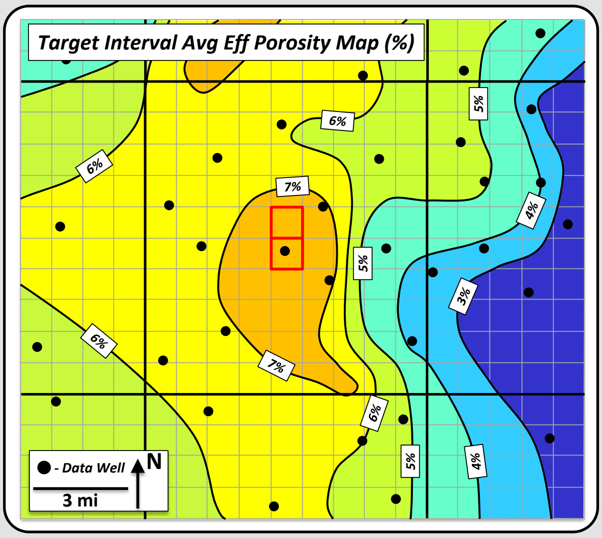


Figure 3 — Isopach map for the hypothetical unconventional reservoir. Inset well cross-section runs west to east through the map area and delineates the top and base of the reservoir. Blue regions on the cross-section indicate interpreted shelf deposits and yellow regions indicate deepwater deposits.

GRV is deceptively complex when considering continuous and laterally extensive resources (e.g., unconventional reservoirs). The geologist might be tempted to estimate the in-place potential of entire mappable formations right down to the last hydrocarbon molecule. However, a full hydrocarbon audit of the Permian Wolfcamp Formation provides little in the way of useful information when it comes to calculating reserves on a flow-unit basis. Thus, when selecting the volume of rock for analysis, it is always important to consider the scope and purpose of the analysis, as well as suitable analogs for productive reservoir intervals and flow units **(Figure 3)**.

Porosity is an important petrophysical property as it represents the potential hydrocarbon storage capacity for the reservoir and other petrophysical parameters depend upon its accurate calculation. There are many logging tools that measure porosity **(Figure 4)**, and the final reported measurement usually comes in two flavors: total porosity and effective porosity. Both calculations require a correction for the amount of organic content in the reservoir (e.g., Kerogen), which is typically established using highly sophisticated logging tools or conventional core analysis. Porosity also serves the dual role of providing cutoffs for a net-pay calculation. In particular, net-pay cutoffs of 2-3% porosity are quite common and applied in most optimistic cases, with 5-6% porosity cutoffs applied in more pessimistic scenarios. Once porosity has been established, water saturation can then be determined for the reservoir interval and mapped accordingly **(Figure 5)**. There are several options available to the geoscientist to accomplish this (e.g., Modified Simandoux, Dual Water Model, Archie's Equation), each with their own inherent strengths and weaknesses. Hydrocarbon saturation is then calculated as 1 (one) minus the water saturation ($1 - S_w$). It is important to note that deriving hydrocarbon saturation from the water saturation only accounts for the liquid hydrocarbon phase and free gas. If the geoscientist or engineer is interested in calculating the potential absorbed gas fraction in the reservoir, then additional conventional core analysis or TOC correlation will be required.



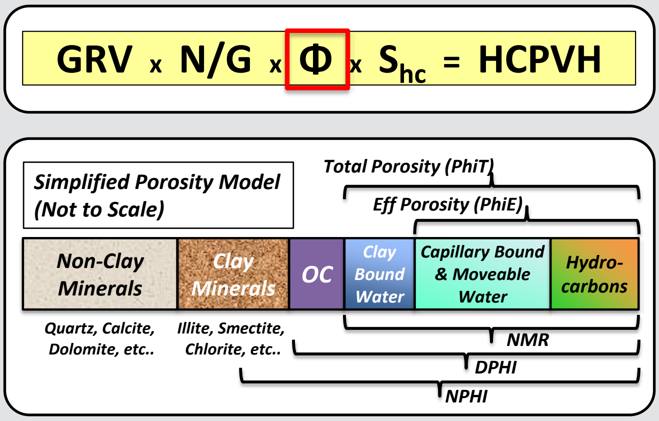


Figure 4 — Average effective porosity map for the hypothetical reservoir. Simplified porosity model illustrates some of the logging tools available for measuring porosity, as well as, the petrophysical distinction between total and effective porosity. OC – Organic Content.

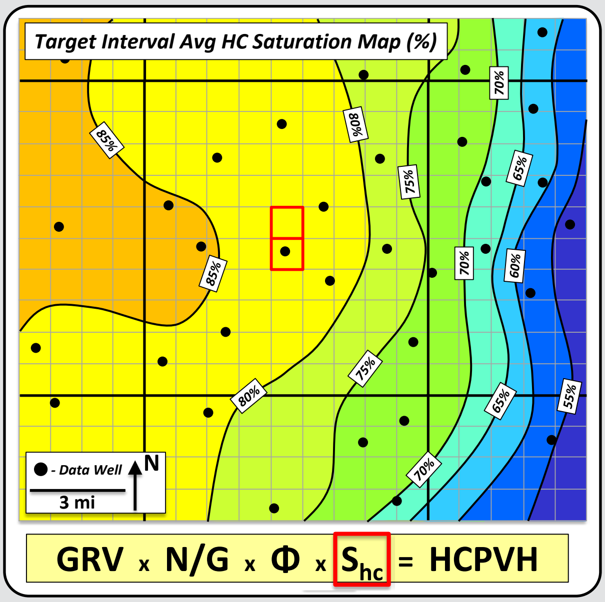


Figure 5 — Average hydrocarbon saturation map.

HCPVH, often referred to as SoPhiH, can be calculated after GRV, porosity, and hydrocarbon saturation have been established. HCPVH can be thought of as a proxy for in-place resource density and can be converted directly to OOIP and/or OGIP if a formation volume factor is known. Maps of HCPVH **(Figure 6)** can be used by geoscientists in various ways: 1) they can aid in establishing reasonable certainty of a subsurface reservoir's lateral resource continuity; 2) as demonstrated in our case study, they provide geologic confidence in the projection of discovered developed resources to undeveloped targets some distance away; 3) they can aid in the selection of analog production areas when generating type-curves for reserves calculation. Going back to our initial example **(Figures 1 & 6)**, resource estimation using the volumetric equation, along with petrophysical maps derived from inputs to the equation, are a helpful tool in assessing subsurface reserves for developed and undeveloped assets.

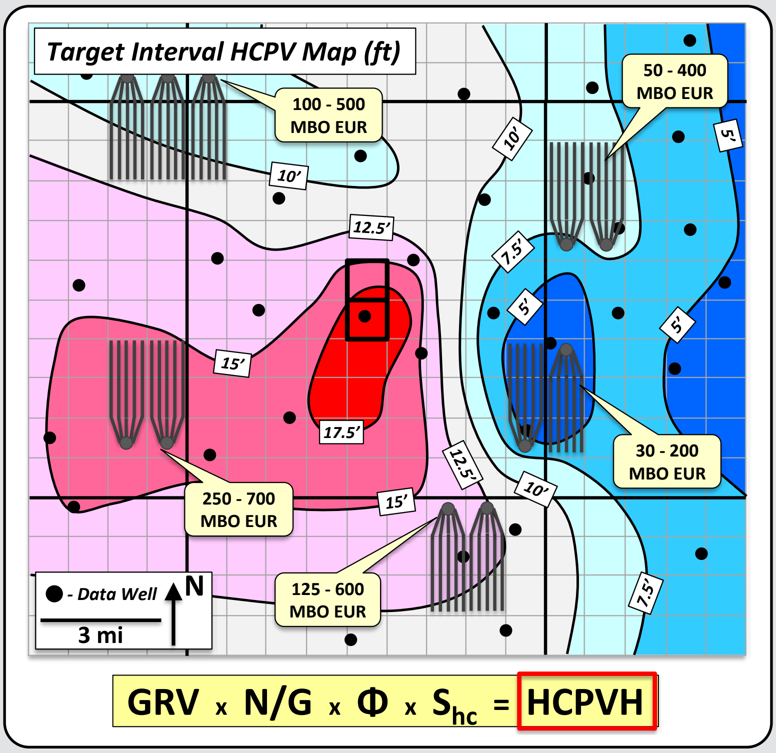


Figure 6 — Hydrocarbon pore volume height (HCPVH) map. Bold black boxes illustrate the same undeveloped acreage from the previous maps. Overlain are the offset production horizontals from Figure 1. HCPVH maps such as this can be useful for understanding resource extent and density. They are also useful for selecting geologically appropriate regions for production forecasting and type-curve development.

Concluding Remarks

Geoscientific analysis is an important tool for the delineation and appraisal of subsurface hydrocarbons in unconventional reservoirs. The case study presented herein demonstrates that traditional geologic methods for volumetric estimation (i.e., volumetric equation) can be utilized to reasonably estimate subsurface resources in some unconventional play types. It is important to stress that resource evaluation is no single individual's purview. Geologists and engineers should work together when estimating subsurface resources to ensure accuracy and reciprocity of results between geological resource density maps and forecasted production type-curves.

Explore Ryder Scott's Geological Consulting Services

Ryder Scott maintains a comprehensive suite of commercial geoscientific software, providing versatility when assessing geological and geophysical data. We apply risk-assessment expertise to undrilled prospects and trends. In some cases, Ryder Scott performs original geophysical mapping and basin modeling work. In any assessment of an exploration prospect, we adopt a method of risk analysis, bring objectivity and consistency to portfolio valuation, and apply discriminating economic criteria to prospect selection.

For more information regarding Ryder Scott's geoscience services, please contact Head of Geosciences and Managing Senior Vice President, Philip Jankowski at Philip_Jankowski@ryderscott.com.

Gilly Rosen (second from the right)
at 2022 AAPG Conference

Dan Olds at
SPE ATCE 2022

Ryder Scott Current Events

During the fourth quarter of 2022, Ryder Scott employees made appearances at AAPG, ATCE, and the University of Houston. Our representatives spoke on several relevant topics which are currently shaping the oil and gas industry. Topics included sustainable energy, PRMS Applications Guidelines, engineering professionalism, and more. Our employees are valuable contributors to the constantly evolving industry, and their abilities, knowledge, involvement, and experience are a major part of why our company continues to lead and grow with the latest technology and trends.

AAPG Conference

Gilly Rosen, Vice President and Petroleum Geoscientist at Ryder Scott, served as a panelist at the 2022 AAPG Conference where she discussed how Ryder Scott has advanced its workflows and best practices to match the ever-evolving technology and trends in the industry while also adhering to the highest standards regarding reserves reporting. Throughout her presentation, emerging technologies and subsequent new directions that Ryder Scott would be taking were discussed.

Advancements in machine learning and predictive analytics are necessary as vast quantities of data must be managed and understood. Since quality assurance and quality control are imperative, Ryder Scott is now ISO 9001 and ISO 14001 certified as part of its commitment to quality standards and processes. Regarding reserves reports and certifications, Ryder Scott continues to be a leader in field evaluations and reserves reports and certifications.

Rosen spoke at length regarding Ryder Scott's growing Sustainable Energy Division. For over eight decades, Ryder Scott has been conducting reservoir and field studies and reserves evaluations. It is precisely for this reason, Rosen states, that sustainability was a natural fit for Ryder Scott. Ryder Scott's extensive experience in enhanced oil recovery projects has provided a smooth transition into sequestration specific projects. "Our experience with auditing and certifying our client's assets in accordance with the SEC and SPE-PRMS Booking Guidelines for reserves is now directly applicable to assessing carbon capture, utilization, and sequestration projects in accordance with

Ryder Ssott 2022 SPE ATCE Booth

SPE-SRS guidelines for CO2 storage capacity," said Rosen.

SPE-ATCE

Ryder Scott hosted a booth at the 2022 SPE Annual Technical Conference and Exhibition held in Houston's George R. Brown Convention Center on October 3-5, 2022.

The theme of this year's event was The New Oil and Gas Journey: Agility, Innovation, and Value Creation. At this event, international speakers discussed necessary strategies that would help maintain business continuity for companies along with their overall competitiveness. Industry leaders, including Ryder Scott employees Dan Olds and Gilly Rosen, participated in discussions on trending topics such as the net-zero transition, accelerating the uptake of new technology applications, financing future projects, energy mix collaboration, and more.

Dan Olds, Managing Senior Vice President at Ryder Scott and current SPE OGRC Chair, presented an update of the committee's current activities at the SPE Pavilion theater.

Before the 2018 PRMS update was released, the OGRC had been working on the related "Guidelines for Application of the Petroleum Resources Management System" that would accompany it. The Application Guidelines (AG) was completely overhauled. There were volunteers from around the world, not only from SPE, but also from the "sister" societies that approve and sponsor PRMS such as WPC, AAPG, SPEE, SEG, SPWLA, and EAGE. Charles Vanorsdale, an OGRC committee member, did a tremendous job as editor. The lengthier, updated version has integrated examples throughout and includes chapters in Petrophysics and Reservoir Simulation. In the 2011 version, each chapter was essentially a stand-alone discussion, but the OGRC fully integrated the chapters throughout the document. The glossary has expanded with additional terms not found in the PRMS as the glossary was limited to only terms actually used in PRMS.

Parallel with the AG, the OGRC was creating stand-alone examples along with a frequently asked questions (FAQs) section that currently covers 42 questions on a variety of topics. The examples and FAQs will be posted on the SPE website with the intent to revise, clarify, or add to both as needed rather than wait for a new version of PRMS.

The AG, examples, and FAQs are set to be posted on the SPE website soon. The release will likely take place before the end of October 2022. In addition, a new release of the PRMS Version 1.02 will be posted to address several minor editing and grammar problems and to clarify consistent treatment of synthetic gas.

The OGRC also presented a position statement to SPE on the use of PRMS principles being applied to non-hydrocarbons. The OGRC was aware of several instances where individuals wanted to use PRMS as the framework to classify and categorize helium and hydrogen (gaseous extraction from reservoirs), lithium and bromine (solution extraction from reservoir brines), geothermal and heat extraction, and synthetic gas extraction from coal seams. In all cases, the exploration and exploitation techniques used would be considered standard oilfield practices, or “oil and gas demonstrated engineering.” It is commonly believed that PRMS provides a better framework than mining guidelines for such situations. The SPE board approved the position statement, which should also appear on the SPE website soon.

UH Petroleum Seminar Series

On October 14, 2022, **Dean Rietz**, Ryder Scott’s Chairman and CEO, spoke about Engineering Professionalism and Ethical Conduct at the University of Houston Petroleum Seminar Series. This seminar series features industry-recognized experts who present on trending industry topics.

Rietz discussed the canon of ethics and guidelines for professional conduct as stated by the Society of Petroleum Engineers. It is expected for petroleum engineers to remain dedicated to ethical practices while making judgments with a fundamental concern for the safety and wellbeing of the public and the environment.

Resume and interview etiquette suggestions were presented to the audience, which was mostly comprised of students.

Rietz encouraged the attendees to actively pursue lifelong education, adhere to the engineering code of ethics, participate in engineering organizations, persevere in their careers, and maintain a healthy work-life balance.

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For more information, please contact Head of Sustainable Energy Herman Acuña, Executive Vice President at Herman_Acuna@ryderscott.com.

Estimates of Oil and Gas Volumes: Unraveling and Understanding the Terminology from Oil-in-Place to Proved Reserves

Below is an excerpt from a white paper written by Ryder Scott staff members including Dean Rietz, Chairman & CEO and Guale Ramirez, President. The paper is intended for an audience not familiar with the terms commonly used in oil and gas reserves evaluation. The full paper will be posted on our website at a later date. Please utilize this paper to cultivate a deeper knowledge among colleagues and friends outside of the industry.

Introduction

Oil and gas industry professionals, such as petroleum engineers and geoscientists, commonly use certain words and terminology specific to the industry. It is important to understand the meaning of and difference between these terms, as press releases or disclosures from exploration and production companies (E&P companies) are distributed in the public domain and therefore, read by an audience outside of the oil and gas industry. Certain industry-specific terminology may be (inadvertently) inappropriately interchanged or simply misused, causing unintended harm related to the use of the disclosed information. The purpose of this paper is to provide the reader a better understanding of certain frequently used terms.

How much oil and gas exists beneath the surface?

There is a fixed amount of oil and gas remaining to be discovered, and recovered, beneath the earth's surface; hence, oil is considered a non-renewable resource. While the amount of oil on our planet is fixed and, therefore, limited, the amount of oil that we can recover (or produce) in the future varies. The three biggest reasons why this recoverable amount changes with time are 1) new information acquired may provide more refined (better) estimates, 2) the development of new exploitation technologies and 3) the economics related to the production of the oil.

Estimating the amount of oil-in-place

Oil and gas volume estimation employs sophisticated approaches, utilizing all available data. Engineers and geoscientists can estimate the number of barrels of oil in the reservoir using equations such as the volumetric equation. The parameters that play a role in such an estimation typically have a degree of uncertainty, usually because a limited amount of naturally varying data is available to perform that calculation.

The estimation of OOIP is important to evaluation engineers, geoscientists and E&P companies as it defines the potential size of a reservoir that has been or is yet to be discovered. Furthermore, it is the starting point for estimating the recoverable portion of oil from a reservoir. The next sections discuss the industry terms ***resources*** and ***reserves***. These terms describe the volume of oil – or the portion of OOIP – in a reservoir that is anticipated to be recovered.

Estimating how much of the OOIP can be produced

Assessing the subsurface resource volumes requires an estimate of OOIP. Of the OOIP, the amount that might eventually be produced is the recoverable portion The factors that influence the recoverable amount include the characteristics of the actual oil (e.g., viscous or heavy with poor flow qualities or light with better flow capability), the characteristics of the rock (e.g., porous with interconnected pore space, permitting the oil to flow), the geological characteristics of the reservoir, the available reservoir energy to transport the oil to the wellbore and lift it to the surface, and the type of operations managed by the operator (e.g. installation of pumping units or other type of artificial lift to assist in lifting the oil). These all affect the percentage of the OOIP that can be extracted from the subsurface. Therefore, even if a reservoir contains a large amount of oil, only a fraction of it, generally in the range of 10% to 40% for oil reservoirs, will be produced. The fraction of the OOIP that is recovered (or to be recovered) is called the recovery factor (RF). Regardless of the estimate of OOIP, the amount of oil estimated to be recovered from the reservoir is the volume that is most important from a commercial perspective.

There can be considerable uncertainty in estimating the amount of oil in the subsurface that can be economically produced as well as the likelihood that those volumes will actually be commercially recovered. In order to explain this aspect of oil and gas exploration and exploitation, the next section focuses on certain applicable terms that shed light on how estimates of recoverable oil are technically classified and categorized.

Petroleum Resources

Resources are separated into discovered and undiscovered in the Society of Petroleum Engineers Petroleum Resources Management System (SPE-PRMS), one of the most common oil and gas classification systems used worldwide. The recoverable resources are divided into production (quantities already produced), reserves, contingent resources and prospective resources. It is the recoverable portion of petroleum resources that can potentially result in commercial income-producing projects for an E&P company. The unrecoverable portion is generally recognized as volume that will remain in the ground (within subsurface reservoirs) until new technology or commercial conditions change such that some additional portion can be considered recoverable.

The distinction between prospective and contingent **resources** depends on whether or not there exists one or more wells and/or other data indicating that a discovery has been made by the drilling of an exploratory well. The distinction between contingent resources and reserves depends on whether a project to develop the discovered petroleum resources is commercial or not. In this sense, commercial defines if a company considers a project worthy of continued investment in order to eventually bring recoverable volumes to market.

There are three classes of resources from the most uncertain and highest risk, to the most likely to be recovered, and finally the least amount of risk and uncertainty. These are summarized below:

- **Prospective Resources:** Estimations of prospective resources volumes are the most uncertain and carry the highest risk. Identifying the risk and uncertainty related to reported volumes of prospective resources is critical to understanding the potential viability and worth of such reported quantities.

- **Contingent Resources:** SPE-PRMS defines contingent resources as “those quantities of petroleum estimated, as of a given date, to be potentially recoverable from known accumulations, by the application of development project(s) not currently considered to be commercial owing to one or more contingencies.” Two of the most prominent contingencies are related to economic conditions (product prices and costs to produce) and technology. Both of these contingencies result in risk and uncertainty related to recovery of such volumes.

- **Reserves:** The third and highest classification of resources in terms of commercial maturity is reserves. These future recoverable volumes have the greatest impact on the value or worth of a company as it relates to exploration and production operations. Oil and gas companies periodically publish a reserves report that reflects the volumes they expect to recover under specific economic conditions. Estimates of reserves are also categorized according to the uncertainty related to the amount of oil that can potentially be produced.

- o Proved reserves provide the lowest uncertainty or highest probability of being recovered. Barrel for barrel, proved reserves possess the highest value.
- o Probable reserves are less likely to be recovered than proved reserves but more certain to be recovered than possible reserves
- o Possible reserves possess a high degree of uncertainty; much higher than proved and probable reserves. As expected, possible reserves should be ascribed a lower economic value per barrel than proved reserves and probable reserves, due to the greater uncertainty pertaining to their recovery.

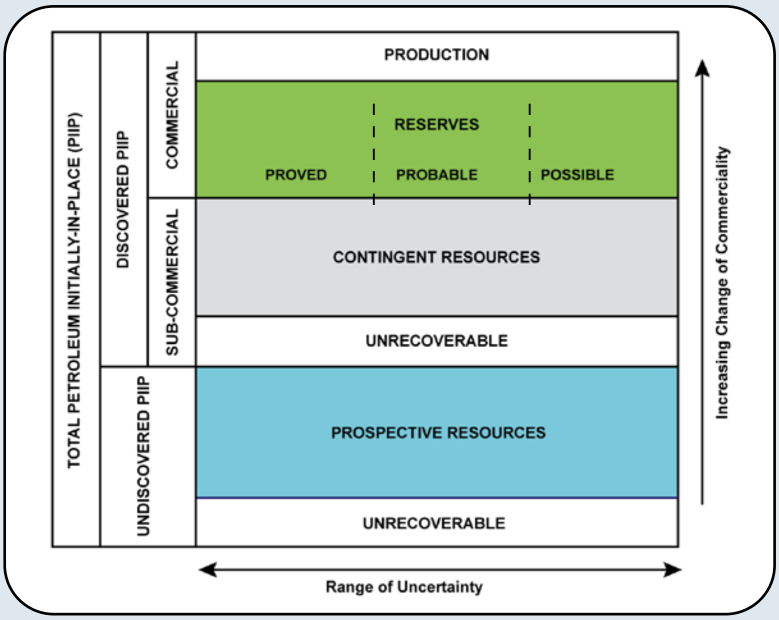
Public Disclosure

Different regulatory bodies throughout the world have specific rules for company disclosures pertaining to the reporting of reserves and/or resources. For example, in the U.S., the Securities and Exchange Commission (SEC) only allows the reporting of reserves (proved, probable, and possible), and most companies will only report proved reserves, even though they can report all three categories. Many companies prefer to inform the investing public what is highly likely to be recovered (i.e. proved reserves), thereby providing a high level of confidence in the estimates along with greater certainty in their ability to deliver the volumes.

Regulatory bodies outside of the U.S. may allow or even require the reporting of additional classifications and categories of resources in disclosures to the investing public. For example, National Instrument 51-101 (NI 51-101), which governs the disclosure of oil and gas activities for securities regulatory purposes in Canada, requires reporting proved and probable reserves and allows for contingent and prospective resources to be reported.

In Summary

While it may be useful to know how much oil is estimated to be in the ground, determining the amount that can be recovered is of greater significance and essential for investment purposes. Recoverable volumes of resources depend on many factors, including among others, the geological nature of the reservoirs, the composition of the hydrocarbon fluids, the operating methods and type of equipment utilized, and the commercial or economic environment (oil prices and costs to drill, produce and transport products). Many of these are complex factors requiring the knowledge and experience of many trained professionals in the geological and engineering professions.



Adapted from SPE-PRMS

Ryder Scott New Hires

Natalie-Nguyen La joined the Ryder Scott Houston office in August 2022 as a Senior Petroleum Engineer with diverse experience in reservoir engineering and petroleum reserves evaluations. Her areas of expertise include production forecasting, waterflood management, field development planning, and integrated reservoir modeling.

Before joining Ryder Scott, La worked for Shell Oil Company, starting as a Reservoir Engineer and working her way up to Senior Reservoir Engineer. In her position, La oversaw forecasting and reporting components of reserves booking. She managed production analog studies and benchmarked dynamic model forecasts against offset wells using decline curve analysis and simple material balance models.

La has coauthored several technical publications discussing such topics as modeling production decline in unconventional formations, characterizing nanoparticle transport in porous media, and production analysis using bottom hole pressure of oil production from an unconventional reservoir.

La has a BS degree in Mathematics and Chemistry from the University of Houston and an MS degree in Petroleum Engineering from The University of Texas at Austin. She is a Licensed Professional Engineer in the State of Texas. In her free time, La enjoys playing tennis, bike riding, and walking her two dogs.

Ekene Ohaegbu joined the Ryder Scott Houston office in September 2022 as a Senior Petroleum Engineer. She has 14 years of experience in reservoir engineering, including reservoir management, economic and reserves evaluation, and A&D evaluations for various oil and gas unconventional resource plays in the U.S.

Ohaegbu worked as a Petroleum Engineering Consultant at EP Valuation where she worked on borrowing base redeterminations for companies seeking reserve-based loans. Before that, she was a Senior Planning Analyst at Marathon Oil Company where she worked closely with multidisciplinary teams, delivered production and financial forecasts for the annual budget/ plan and quarterly plan updates, and analyzed planning scenarios.

Ohaegbu was previously a Senior Reservoir Engineer and Field Development Team Lead at Murphy Oil Corporation. She managed south Louisiana fields and Eagle Ford shale assets focusing on field development planning, evaluating and estimating reserves, evaluating the economic viability of oil and gas projects, and supporting the business development teams by providing technical due diligence for acquisitions and divestments of assets. Ohaegbu also worked as a Reservoir Engineer at Quicksilver Resources Inc. and Schlumberger Data and Consulting Services as a Reservoir Engineer.

Ohaegbu holds a Bachelor of Engineering in Petroleum Engineering from the Federal University of Technology, an MS degree in Petroleum Engineering from Texas A&M University, and an MBA from the University of Houston. Ohaegbu enjoys volunteering in her community, traveling, and painting.

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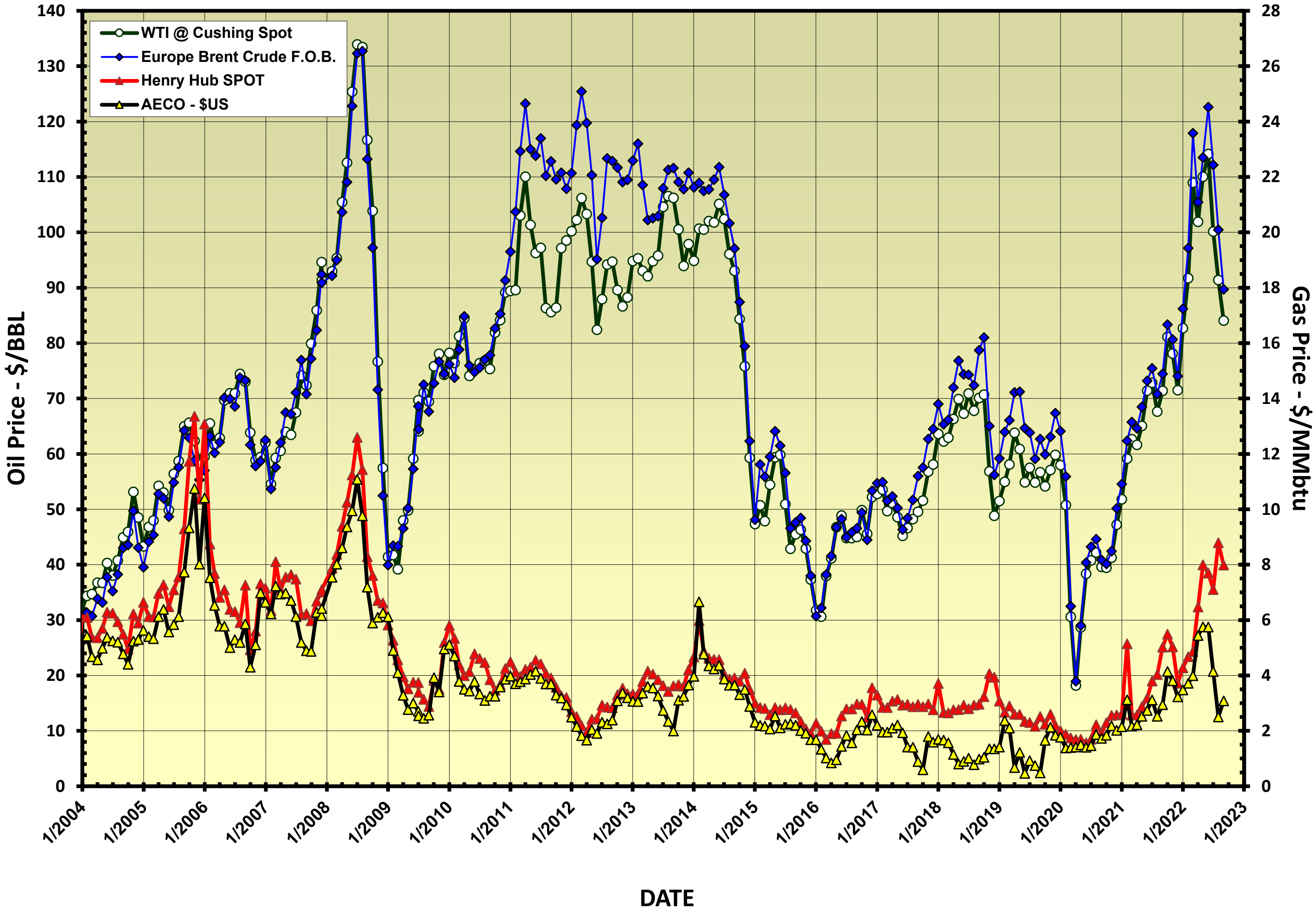
Price History of Benchmark Oil and Gas in U.S. Dollars



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

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