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Technologies Drive Data Enhancement

Editor's Note: Data and technology providers such as TGS are helping operators capture upside potential on their foundational assets. A Q&A with Matt Mayer of TGS provides insight.

Q: *One of the hallmarks of shale plays is that they are located within legacy basins with histories of conventional development. Given all the vintage data and the new data acquired from unconventional reservoir development, how can this universe of information be analyzed to find new discoveries in and around established basins? What types of data and technical tools can optimize the drilling and development decision making process?*

MAYER: Legacy basins are currently in the sweet spot of where data enhancement can really drive decision making to optimize development and growth. Newer processing techniques using machine learning and artificial intelligence can make use of these data-rich areas to enhance the often poorer quality of legacy data and combine disparate datasets to create insights and solutions.

The main thing missing from many contemporary machine learning and AI applications that keep them from being more widely trusted and adopted is a sufficiently large dataset to train the models. This turns out to be a perfect match for legacy basins, which have an overwhelming amount of data to train and validate results using blind tests from held-back datapoints. The exciting thing about these workflows is that each incremental step forward is compounding. For example, upscaling logs to include five major curves across the entire well interval not only makes that individual log more useful, but it also adds more data as an input to create larger-scale interpretations.

In petrophysical and log analysis, machine learning has been especially useful in upscaling legacy data quality. Missing log tracks or depth intervals can be reliably filled in using multivariate relational machine learning algorithms, which allows for better characterization of rock properties and creates standardized and complete datasets. Then, using a training dataset of geologist-picked tops, machine learning algorithms can be trained to efficiently pick equivalent tops for thousands of wells across the basin. These machine-learning-picked tops then can be used to create a unified basin stratigraphic model, which supports higher-level interpretations and analyses. Each step along the path creates new tools and solutions to solve problems ranging in scale from individual wells all the way up to conceptual understandings of a play.

Another area where machine learning has continued to enhance decision making is in cross-disciplinary geological and geophysical models. Seismic surveys always have been a highly valued tool in evaluating plays for potential exploration and development, but generating insightful knowledge is a heavily resource-intensive task that may not be suited to answer all relevant questions needed to make better development decisions. However, recent case studies have shown solid evidence that combining geophysical data with petrophysical data in a machine learning model can create unique interpretive solutions.

Machine learning seismic inversion methods have been shown to confidently predict properties such as p-impedance and density at a correlation of 0.88 and 0.70, respectively, providing results that are at or above the upper threshold for prediction from traditional inversion techniques. These methods can predict with

higher accuracy, at a higher resolution, and faster than traditional inversion methods. Machine learning is also being used to identify patterns in seismic, such as notoriously hard-to-find salt structures in offshore settings. The practical implications of these workflows are better reservoir characterization to find higher-quality pay and more efficient completion designs.

Overall, the big new thing is creating tools that fuel better decision making and are more widely accessible to more key players. The major pieces required to create these tools include a vast inventory of G&G data in legacy basins and an innovative approach to processing using machine learning that results in outcomes that are far more valuable than the sum of their parts. We think these tools will allow for better decision making and resource allocation, which will really be the key driver in success for unconventional plays moving forward.

***Q:** In keeping, how can operators better evaluate and analyze their existing leaseholds in established resource plays to gain new perspectives on infill development and ultimately add upside value and recoverable reserves?*

MAYER: In the current economic environment, unconventional plays require a precise balancing act of managing costs and highly informed decision making on where to most efficiently allocate resources. The days of true resource plays and mass indiscriminate development are, in all likelihood, behind us. In order to survive, operators will need to be laser-focused on which assets are most likely to yield a high return on investment. The good news is that insightful decision making is more accessible than ever, especially to smaller operators that may not have the staff or lead time that historically has been required to build full-scale geologic models and simulations.

One of the major barriers to effective infill development of existing assets is the uncertainty regarding the detrimental effects of well interference. This type of analysis can be done through full-scale models using precise completions, fracturing and monitoring data. But the real innovation is the growth of generalized visualization and interpretation modules that can perform the same analysis using more commonly available datasets in a fraction of the time. This is the type of interpretive data that big players have always had access to, so making it easier to generate and more broadly available helps to level the playing field in the decision making space.

***Q:** What does the data generally tell us about production performance over time in the major shale basins? Are we seeing distinctive trends regarding productivity and decline patterns? What do they imply about the way forward in these plays as commodity prices recover?*

MAYER: One trend we are seeing develop at varying levels across multiple unconventional plays is simultaneous increases in well completion costs, initial production rates and decline rates. This has a tangible impact on project net present values, which place a higher value on quicker returns on investment, but also means that future gains in oil prices may be less effectively capitalized on by existing wells.

An unconventional play such as the Delaware Basin might be poised to take advantage of this new development for a couple of reasons. The biggest factor is that Permian plays tend to produce significantly higher volumes of water than many other unconventional plays, and as the common water disposal target formations are becoming overcharged, the price of water disposal is steadily increasing. If these newer trends shift more of the production to the first couple of months, effectively shortening the life of the well, then that also leaves less time necessary to produce and then dispose of higher water volumes.

***Q:** What about conventional reservoirs? Are there basins where conventional development has a strong economic rationale as prices continue to recover? Could we see an uptick in conventional exploration any time soon?*

MAYER: Onshore U.S. conventional development is likely to continue to remain fairly close to its current trajectory.

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Unlike unconventional plays, where dynamic economic conditions could potentially open access to innumerable price-sensitive reserves, the driving limitation of conventional plays is diminishing reserves. However, many regional players who have carved out profitable niches in conventional reservoirs using a variety of techniques to enhance production, such as horizontal infill drilling in existing fields or EOR flood operations, will continue apace.

One development concept that may see an upside if economic conditions turn more favorable lies at the fringes between conventional and unconventional reservoirs. "Halo" plays, marginal areas of conventional plays that have been left undeveloped due to poor reservoir quality, can be more efficiently exploited now using various drilling and completion techniques learned from unconventional shale operations.

Two areas where we see a lot of potential for halo plays include the clastic reservoirs in the Powder River and Denver-Julesburg, which are both Cretaceous basins with similar characteristics and extensive development histories. The rich data history in these legacy basins will help to identify the most productive formations and facies. There potentially may be dozens of lower-quality paralic deposits surrounding historic fields in these basins that could develop into productive trends.

Another development concept that may play an increasing role moving forward is offshore conventional projects. While this would rely not only on favorable economic conditions but also on favorable regulatory and leasing conditions, some promising opportunities are still available in U.S. offshore areas. The Artic National Wildlife Refuge North Slope play has the potential to rival the Prudhoe Bay Field, and in state waters on the Gulf Coast, there are promising indications of an ultradeep play in the Wilcox that could lead to a huge discovery. ❐