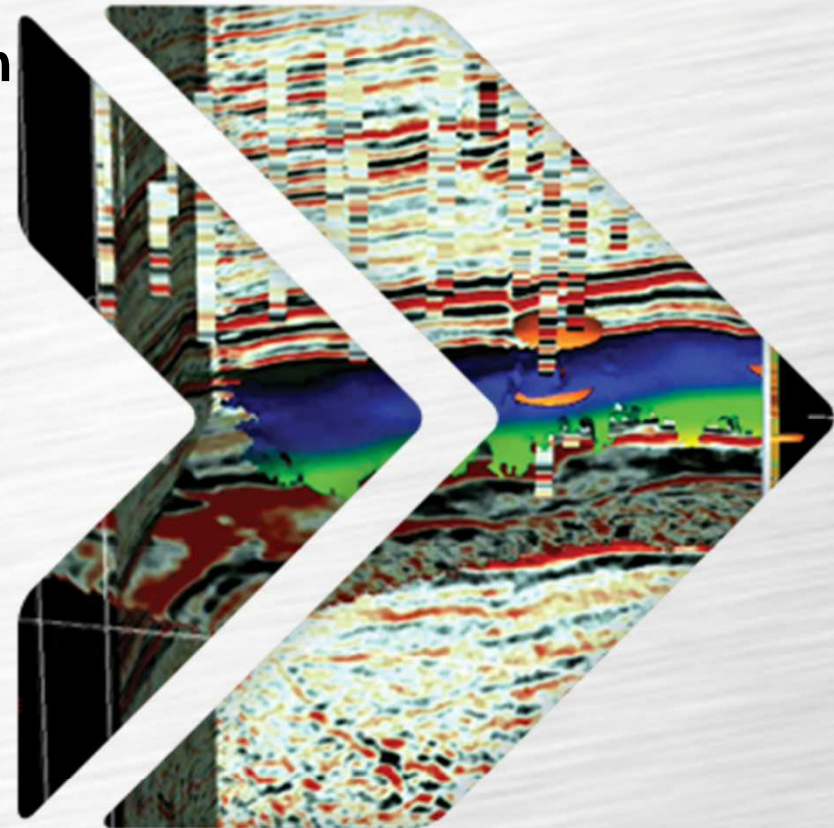


The importance of predictive modeling to geologic and engineering grading, and information sharing for optimizing results in unconventional hydrocarbon developments

September, 2014



Alvaro Rios Roca
Partner Director



Index

- DI & Gas Energy Latin America presentation
- Background
- Overview of U.S. unconventional hydrocarbon development
- What is predictive modeling?
- What is grading acreage?
- What is sharing of information?
- How to use predictive modeling to grade the acreage to develop Vaca Muerta
- Conclusions

Multi-Disciplinary E&P Data Management and Visualization Predictive Software of the Future

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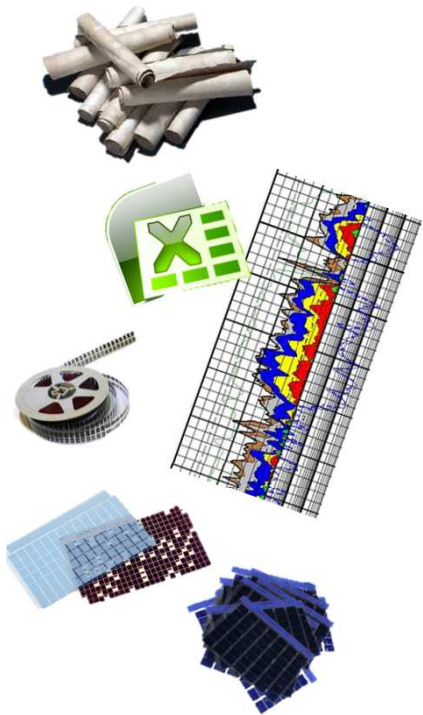
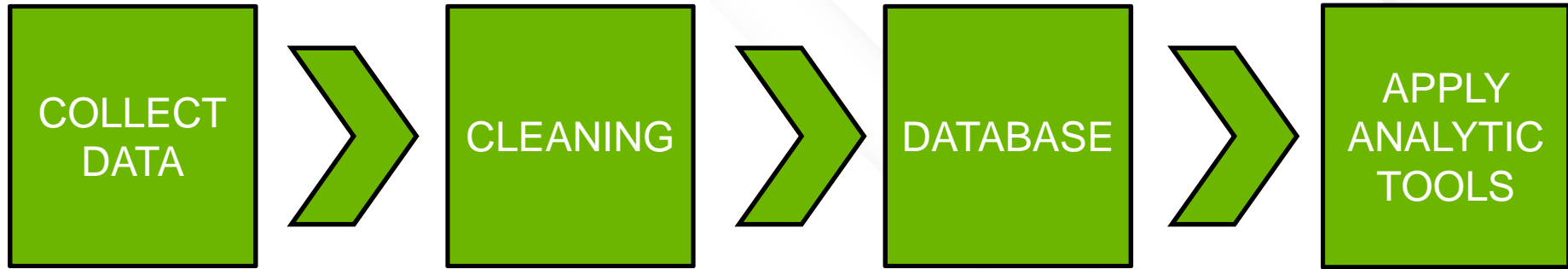
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DI Process Overview - Upstream



Gas Energy Latin America - The Company's History

Downstream



Headquarters & Offices

GAS ENERGY LATIN AMERICA (GELA) is a consulting and advising company, focused on the areas of oil, gas & electric power, operating throughout Latin America.

Technical Offices:

Bolivia and Peru: for Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, Uruguay, Venezuela and other countries in Latin America.

Specialized Senior Consultants:

In each country



Consulting Areas: Oil & Gas

- ✓ Supply and demand analysis
- ✓ Legislation and regulatory analysis
- ✓ Support in the negotiation of natural gas purchase/sale contracts
- ✓ Review and modeling of transportation and distribution tariffs
- ✓ Price analysis and competitiveness analysis of different fuel sources
- ✓ Cost and feasibility studies for investment projects
- ✓ Market research and strategic planning for oil & gas businesses
- ✓ Due diligence processes (both technical & commercial)
- ✓ Monetization opportunities analysis for hydrocarbon reserves

Consulting Areas: Power Sectors

- ✓ Supply and demand analysis
- ✓ Legislation and regulatory analysis
- ✓ Analysis of prices in wholesale electric power markets, transmission & distribution tariffs
- ✓ Technical, economical (costs) and regulatory assessment for power plants, transmission lines & distribution grid projects
- ✓ Development and review of supply contracts
- ✓ Studies related to the expansion planning of power systems, including quality and power losses issues
- ✓ Support in the formulation of strategic plans and in the quality certification process

Types of Services Offered

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MULTI-CLIENT STUDIES
Peru & Venezuela

REPORTS
LATAM Energy Markets (LEM), Market Report & Energy Insight - Venezuela

Index

- DI & Gas Energy Latin America presentation
- Background
- Overview of U.S. unconventional hydrocarbon development
- What is predictive modeling?
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- What is sharing of information?
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Background

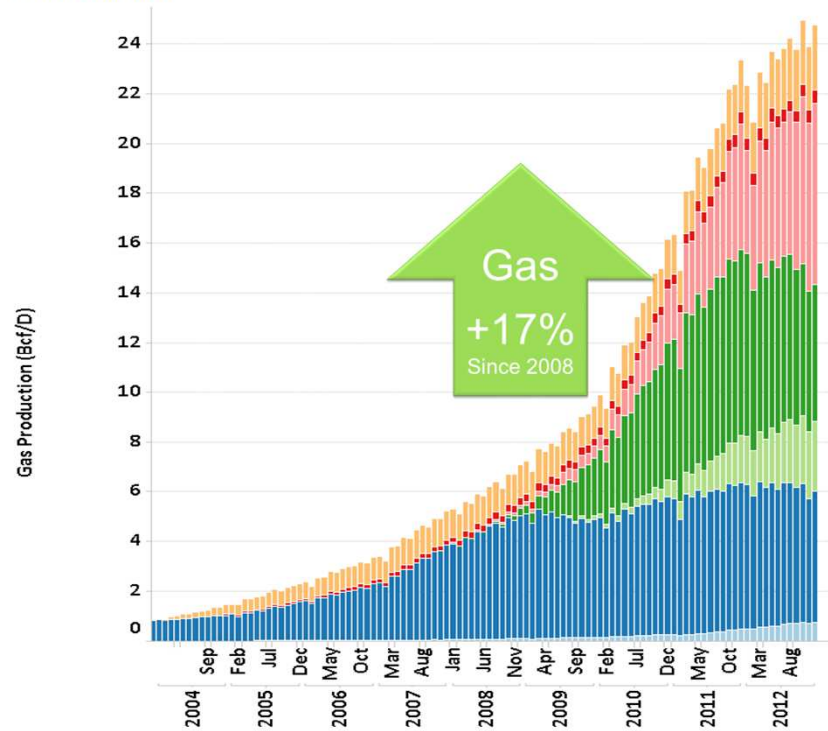
- Present basic concepts regarding predictive modeling, and geologic and engineering practices of prospective grading an acreage to optimize results in unconventional hydrocarbon developments
- Analyze the benefits of information sharing in implementing these concepts and in overall results
- Analyze how predictive modeling is being applied in other new plays in the U.S. and how expanding the practice globally could result in extensive benefits, mainly in those plays in mature basins with plentiful geological information.
- Analyze the above on Vaca Muerta formation in Argentina

Index

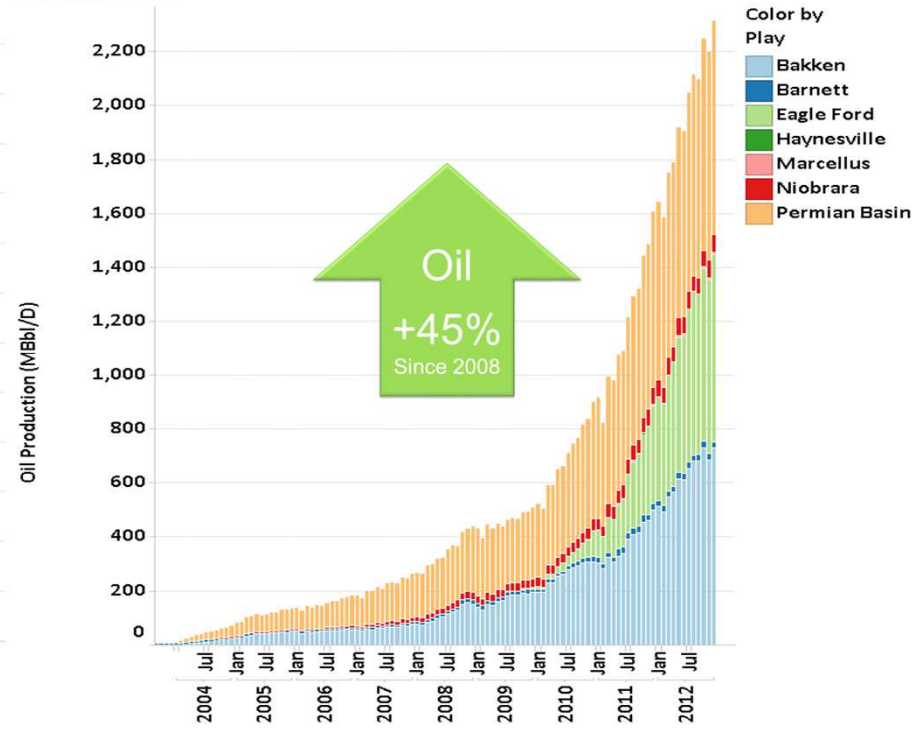
- DI & Gas Energy Latin America presentation
- Background
- Overview of U.S. unconventional hydrocarbon development
- What is predictive modeling?
- What is grading acreage?
- What is sharing of information?
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- Conclusions

U.S. Shale gas and shale oil boom

Gas Production



Oil Production



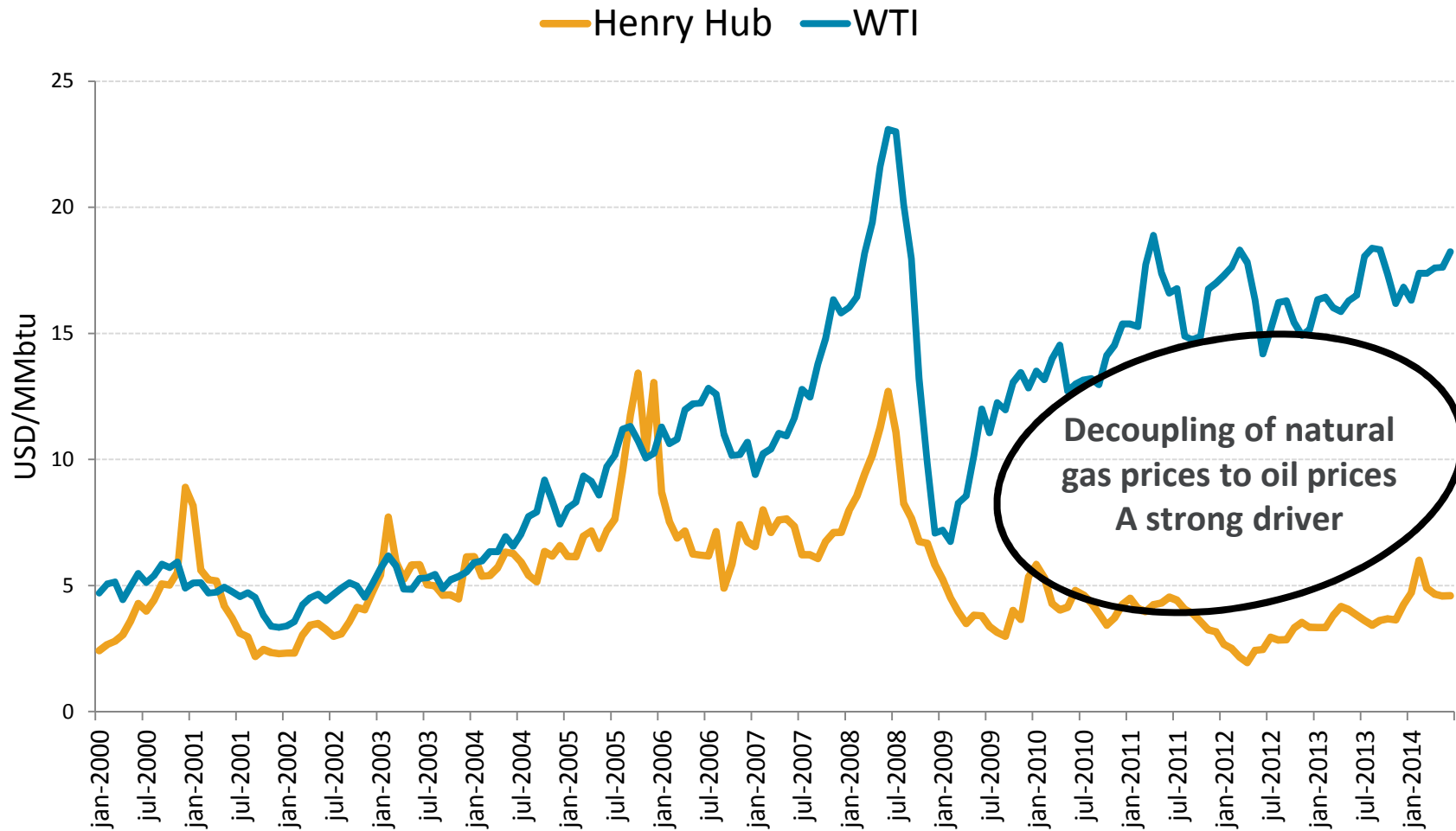
Shale production 2013: Shale gas: 26 BCF/day (5.11 MMBod)
 Shale oil: 3.5 MMBod

Total shale oil + shale gas = 8.61 MMBod
 Mexico and Venezuela production = 7.60 MMBod

2004 – 2013: Over 120,000 wells (Argentina 170 Wells in 4 years)
 Cost savings: Gas 12 USD/MMBTU – 508,000 MMUSD
 Oil 90 USD/Bbl – 34,000 MMUSD

Total saving: 542,000 in 10 years
 Average annual saving: 55 billions of dollars

U.S. Shale gas and shale oil boom



U.S. Shale gas and shale oil boom

Effects:

- ✓ Strong reduction of natural gas imports & start prospecting LNG export projects.
- ✓ Power generation: Switching from coal to natural gas
- ✓ Reactivation of manufacturing industries and petrochemical
- ✓ Technology developments to develop transportation with mini LNG and CNG (technological advances)
- ✓ Job creation
- ✓ Dow stock keeps going up
- ✓ Financially hedged industry????



Index

- DI & Gas Energy Latin America presentation
- Background
- Overview of U.S. unconventional hydrocarbon development
- What is predictive modeling?
- What is grading acreage?
- What is sharing of information?
- How to use predictive modeling to grade the acreage to develop Vaca Muerta
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What is predictive modeling?

About concepts!

1st Predictive analytics encompasses a variety of statistical techniques from modeling, machine learning, and data mining that analyze current and historical facts to make predictions about future, or otherwise unknown, events. (Wikipedia, 2011)

2nd Predictive models are the relation between the specific performance of a unit in a sample and one or more known attributes or features of the unit. The objective of the model is to assess the likelihood that a similar unit in a different sample will exhibit the specific performance. (Wikipedia, 2011)



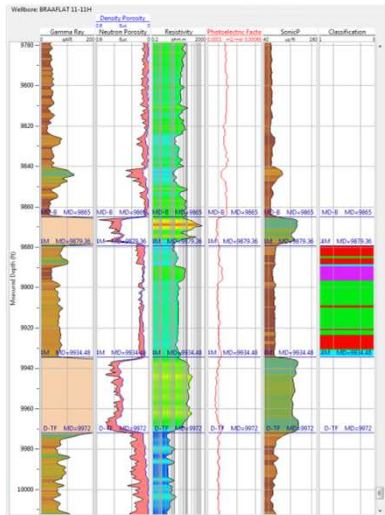
- For the shale gas/oil industry, predictive modeling techniques such as regression analysis are used to grade the acreage (play or area within a play)
- Acreage grading uses predictive models to find the relationship between geology and engineering data and known production.
- It is important to use as much **relevant** data as available.

How predictive modeling works?

Geology Data

Ex.:

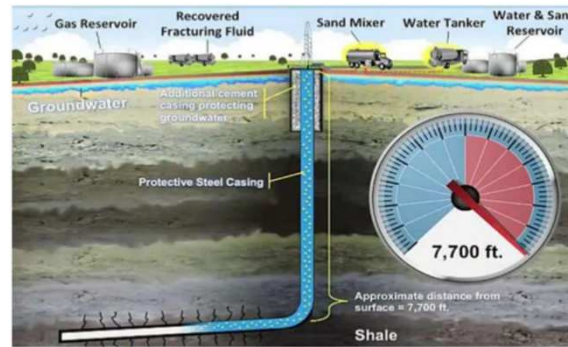
well log attributes: gamma ray, resistivity, porosity and many others.



Engineering Data

Ex.:

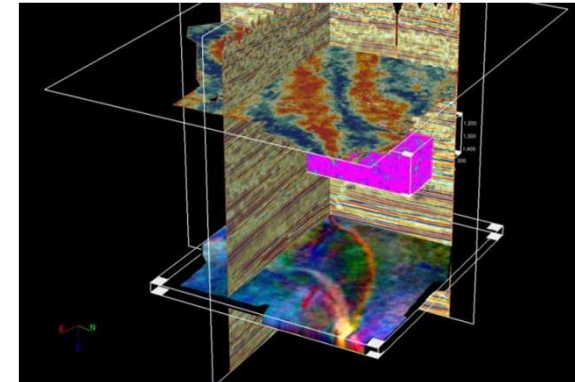
amount of proppant, lateral length, amount of fracture fluid and literally dozens of other parameters



Subsurface Data

Ex.:

2D, 3D, microseismic and more lately 3-C and 9-C seismic can be used.

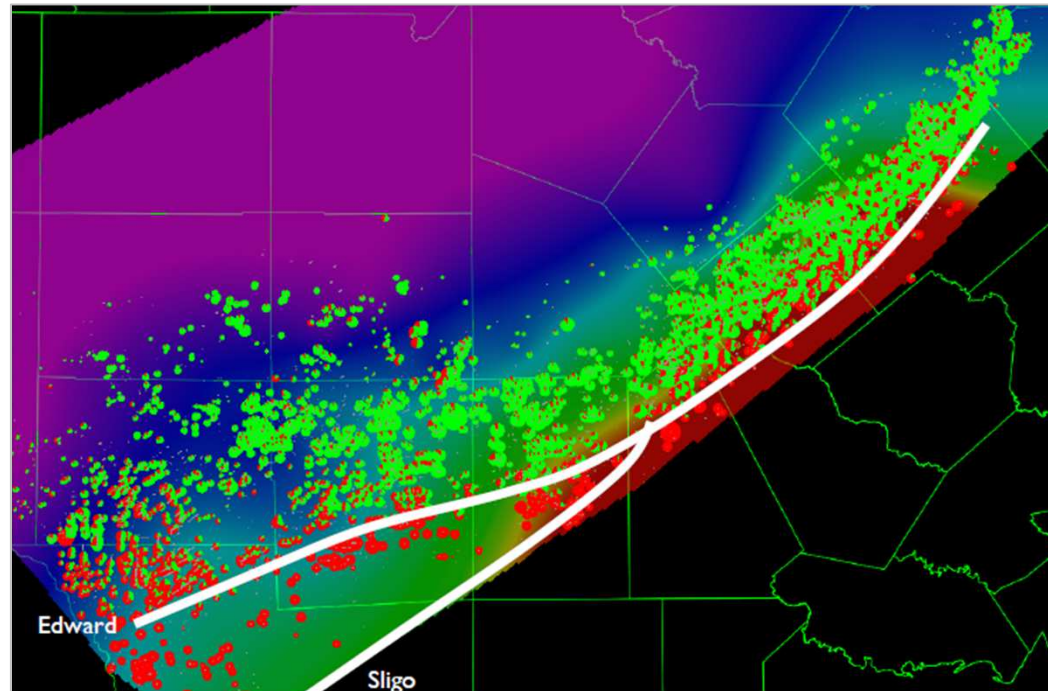


Data is input into the predictive model and the correlation between it and known production is established.

Results

- ✓ Correlation used to **predict production anywhere** where the geology data exists, regardless if there is production or not.
- ✓ Predictive modeling to grade the acreage (play) allows to characterize regional or local sweetspots and predict production
- ✓ Enormous value:
 - Much better than guessing
 - Establish
 - Monetization techniques
 - Recovery factors
 - Creating value to capital.

Eagle Ford sweetspot map with normalized engineering



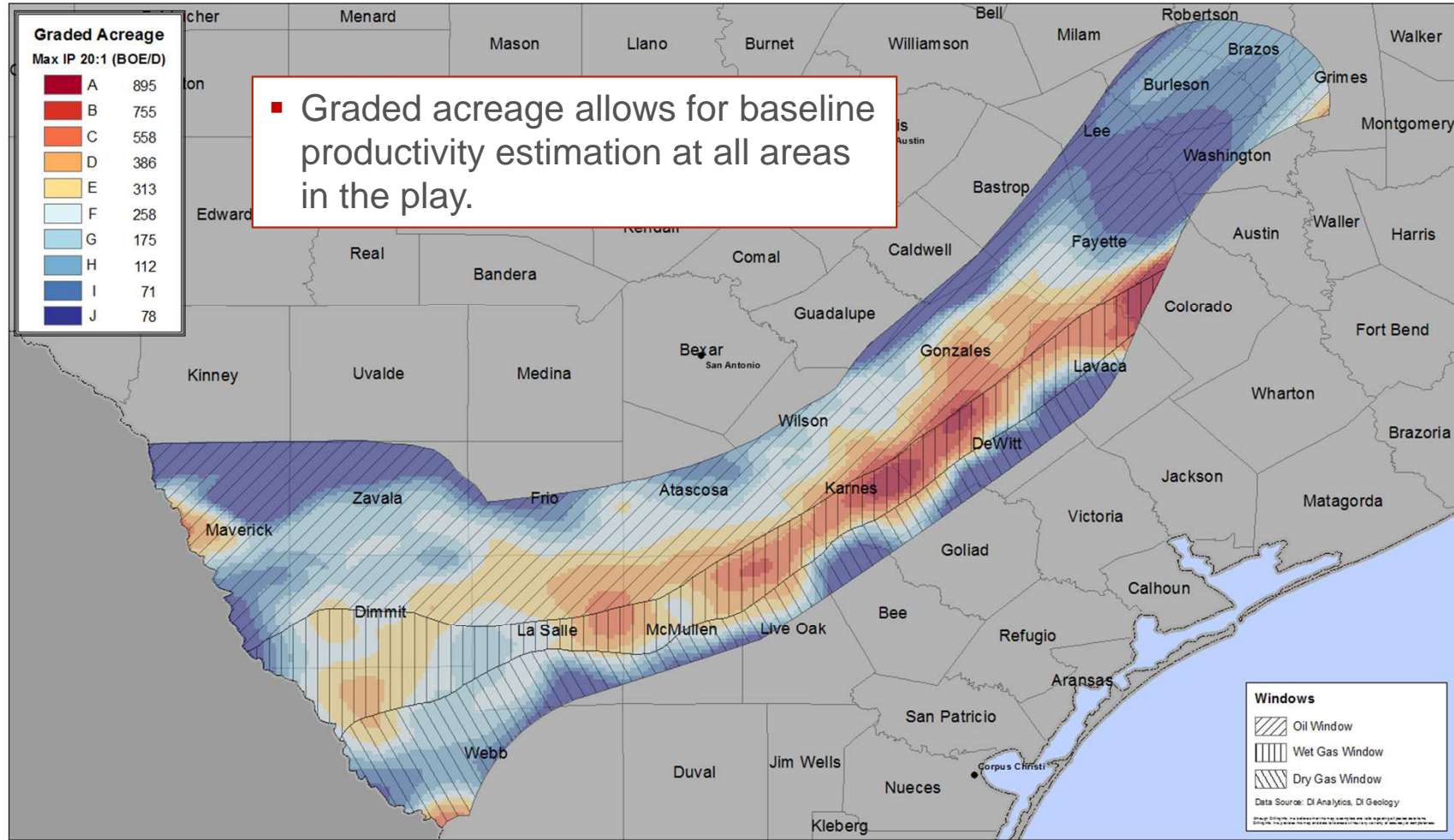
Index

- DI & Gas Energy Latin America presentation
- Background
- Overview of U.S. unconventional hydrocarbon development
- What is predictive modeling?
- What is grading acreage?
- What is sharing of information?
- How to use predictive modeling to grade the acreage to develop Vaca Muerta
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What is grading an acreage?

- ✓ Grading an acreage is an evaluation of a plot of land to ascribed to its natural prospectivity to produce hydrocarbons.
- ✓ To be accurate requires a lot of **relevant** well data (well logs) and reasonable interpolations and extrapolations of such between and beyond well bores.
- ✓ **These observations are compared to production data in a sophisticated non-linear manner to generate graded acreage maps that normalize what rocks have the highest propensity to produce.**
- ✓ These analyses are done for gas, liquids, and economic deliverability independently.

Eagle Ford Acreage Grading

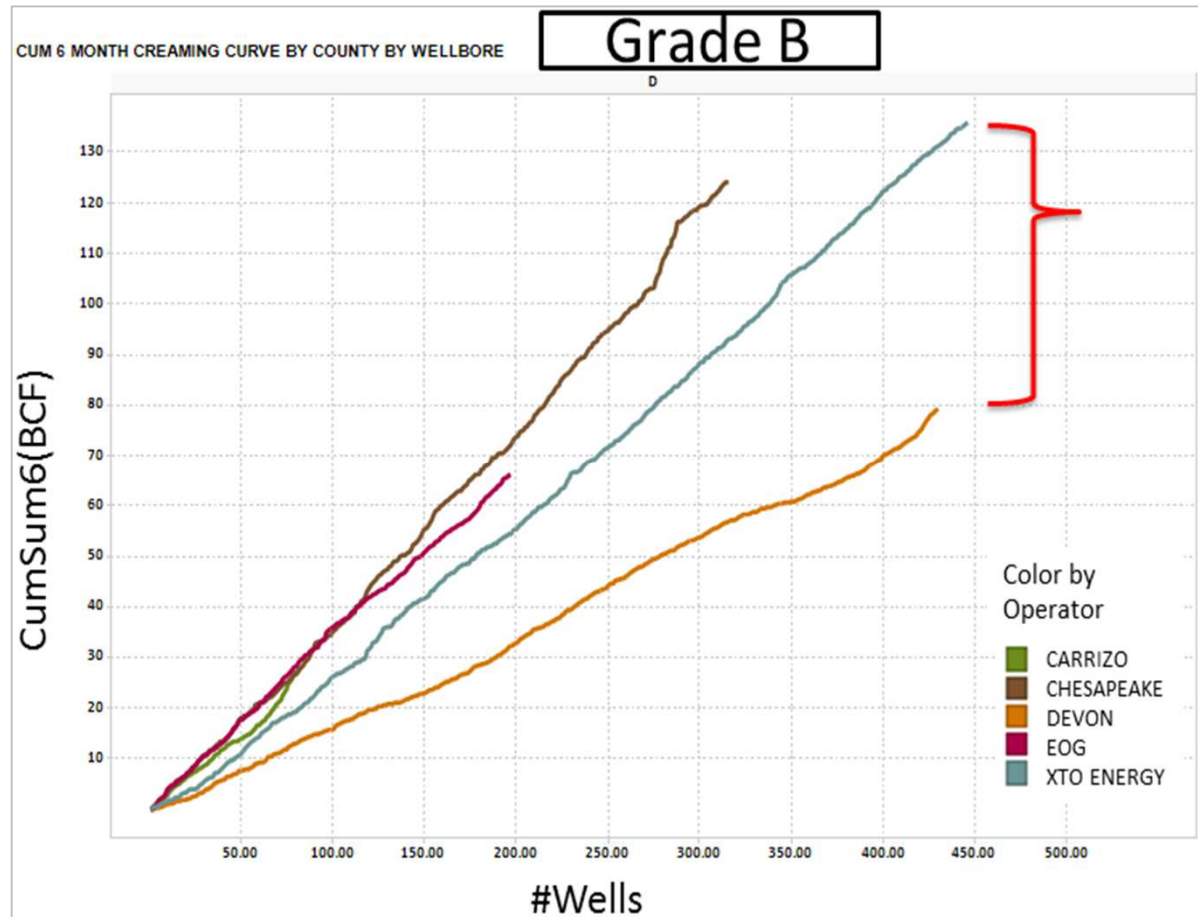


The economic deliverability grading result of the Eagle Ford play in south-central Texas

Eagle Ford Acreage Grading

Benefits: Explore Acquisitions and Divestiture (A&D) opportunities

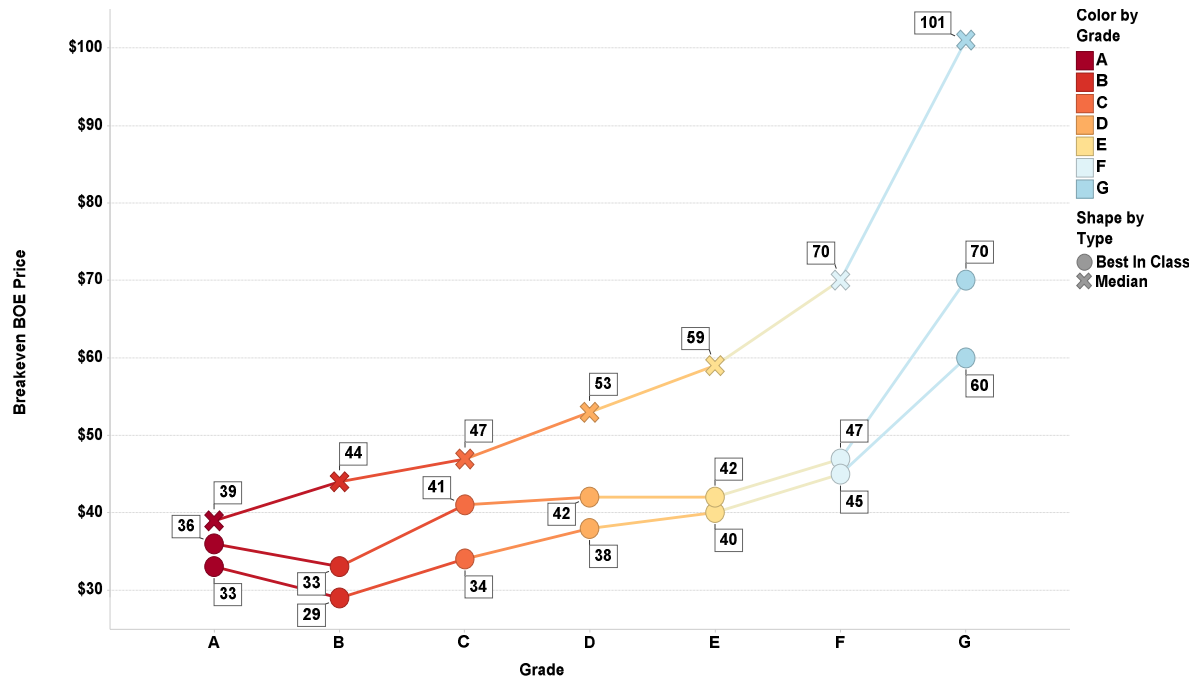
- Rank operators based on productivity for possible acquisitions or partnerships



- ✓ Screening tool for entities looking to buy working interest in US unconventional plays
- ✓ Difference between a marginal operator and best in class can be upwards of 30%-40% productivity.

Benefits: Explore Acquisitions and Divestiture (A&D) opportunities

- Quantify risk with sensitivity analysis in various grades



Sensitivity analysis reveals that in core areas the difference in breakeven prices is fairly small \$3-\$6 / BOE.

The risk begins to increase as acreage diminishes \$20-\$30 / BOE.

- Gives context to leasing information, better decisions during the leasing process
- Identify and quantify the particular engineering practices that maximize production in particular grades

Benefits

Evaluate assets

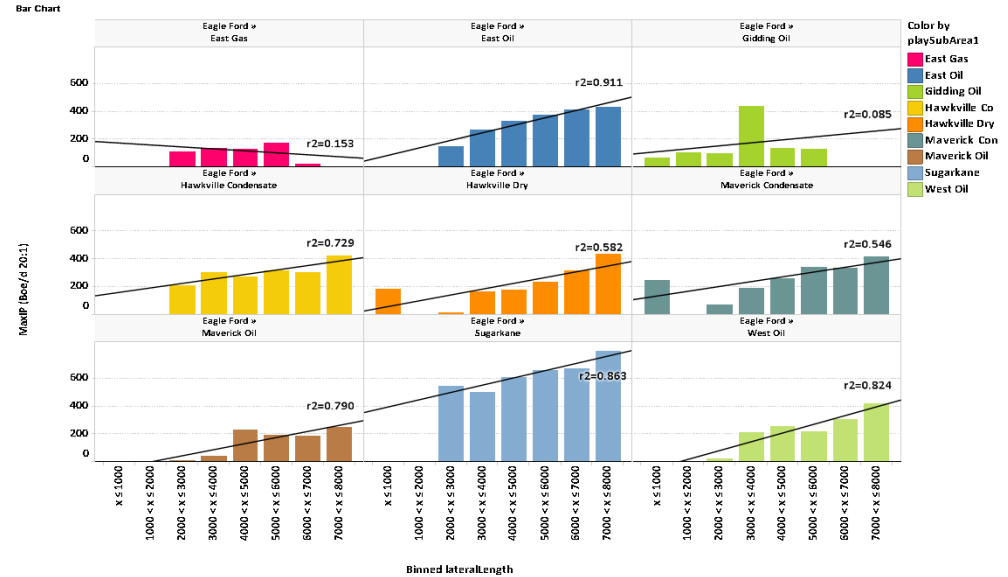
- Quantify core versus non-core
- Assess recoverable resource potential
- Target underperforming assets

Understand Best Practices

Explore productivity potential in plays with no production

If geologists believe a geologic basin is similar to another where acreage grading exists, predictive model is used to understand the potential productivity of geological analogs.

MaxIP vs Lateral Length By Play Area – Significant only in Core Areas



Index

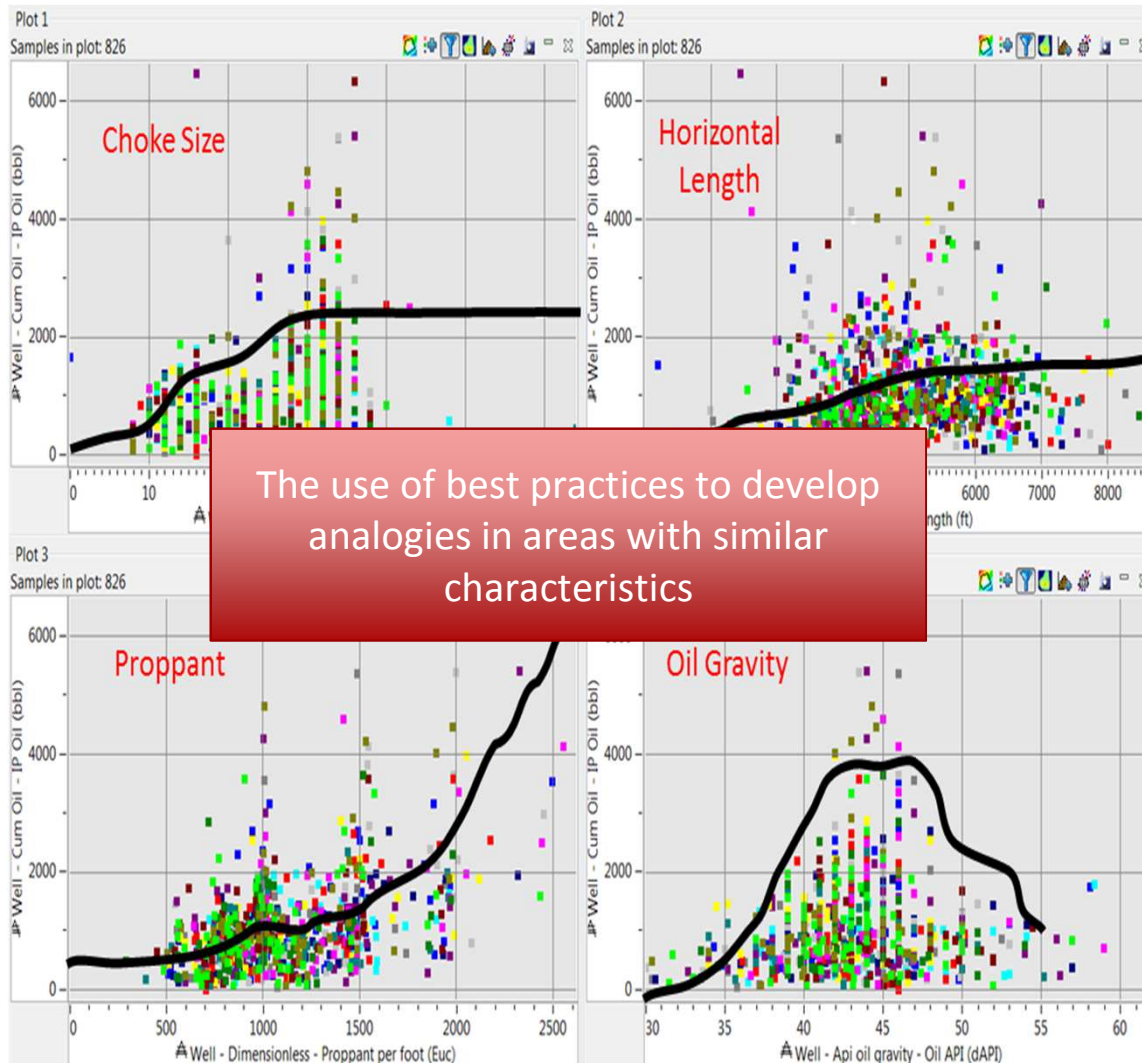
- DI & Gas Energy Latin America presentation
- Background
- Overview of U.S. unconventional hydrocarbon development
- What is predictive modeling?
- What is grading acreage?
- What is sharing of information?
- How to use predictive modeling to grade the acreage to develop Vaca Muerta
- Conclusions

DI Information Process



Development of the unconventional industry in U.S. has been driven by sharing of information or the exchange of data and information

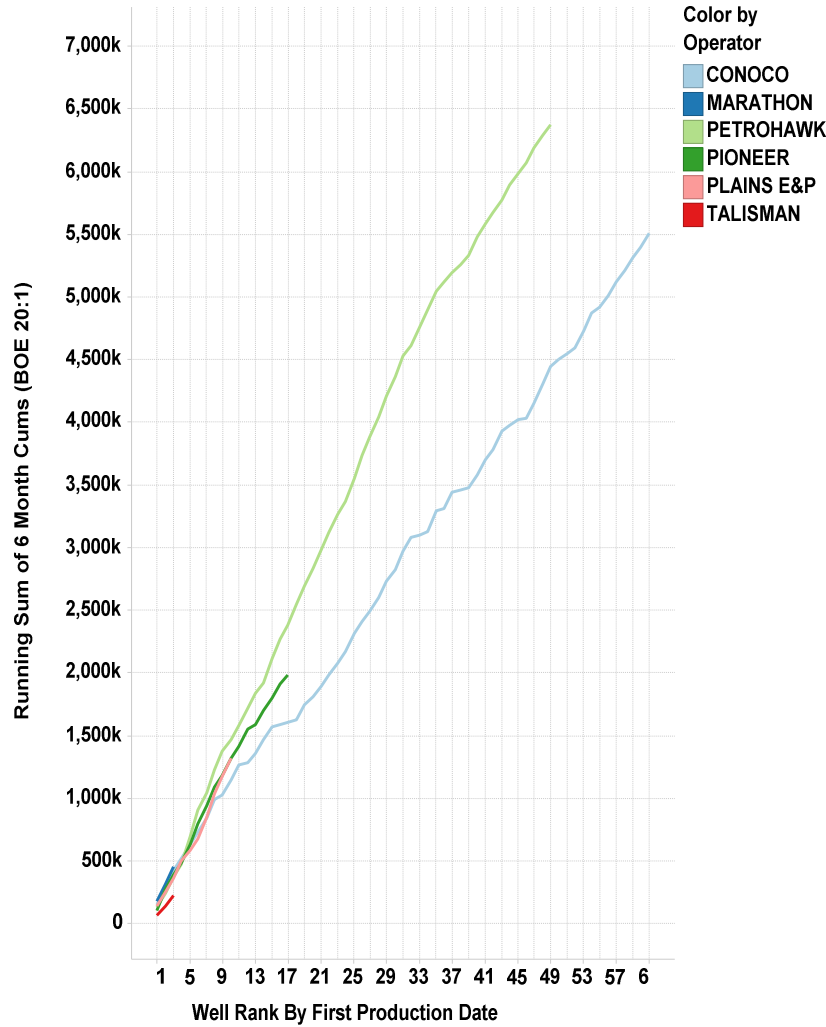
Optimize Production Through Best Practices



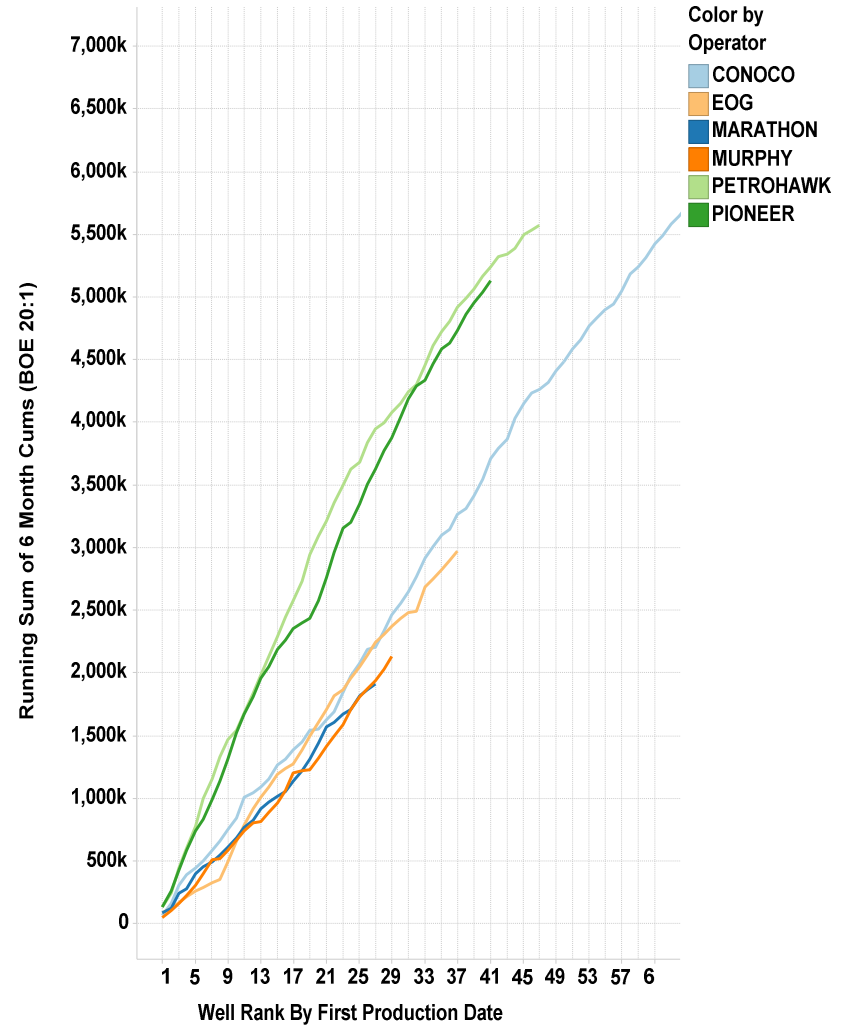
- ❖ Without sharing information valuable analysis could be lost.
- ❖ Operators could not perform geological comparative studies and tendencies to improve their performance across zones in a determined play.
- ❖ Benefits for the overall industry by increasing production and returns of investments.

Best Practices – Sharing of Information

Creaming Curve - A Grade

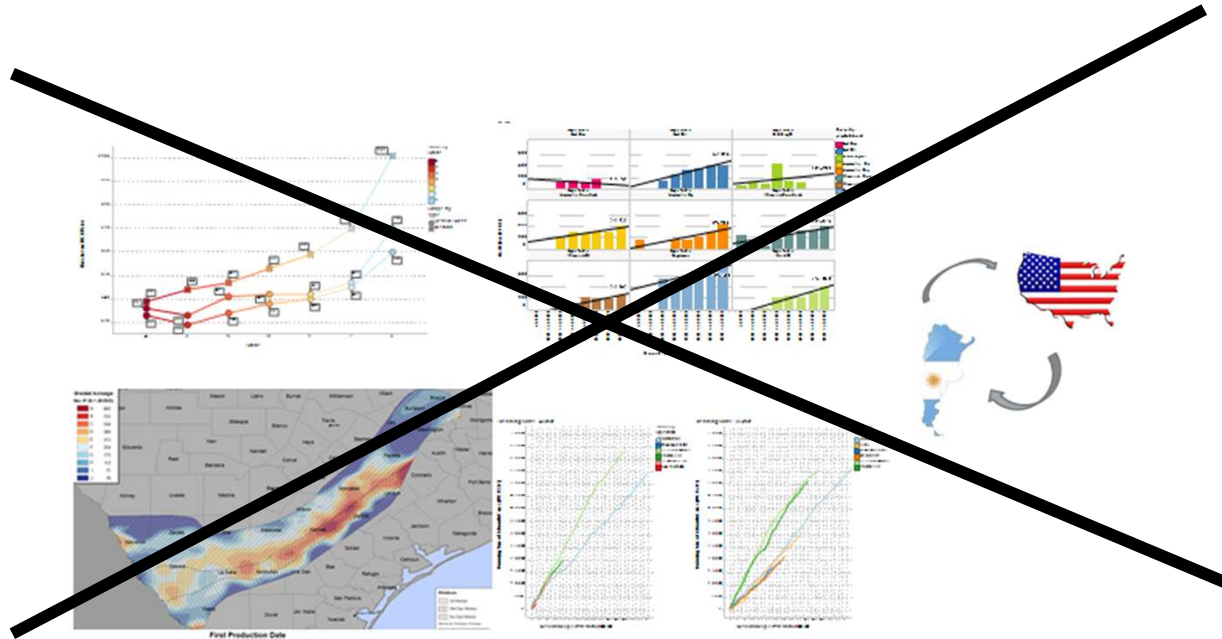


Creaming Curve - B Grade



Importance of Sharing of Information

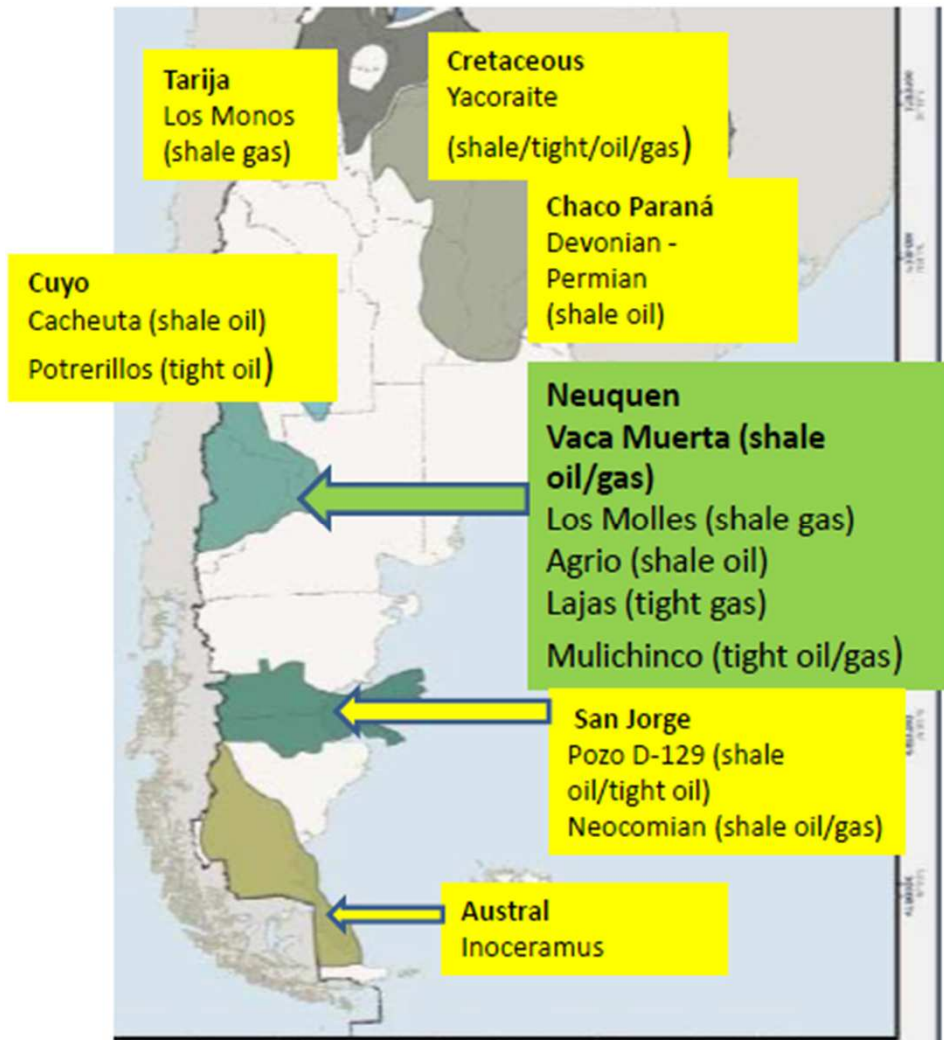
Without sharing data, it would be very difficult to perform more accurate predictive modeling and acreage grading, which in turn will not allow more clearly determining or predicting sweetspots within a play, neither compare best practices across a play or plays around the world.



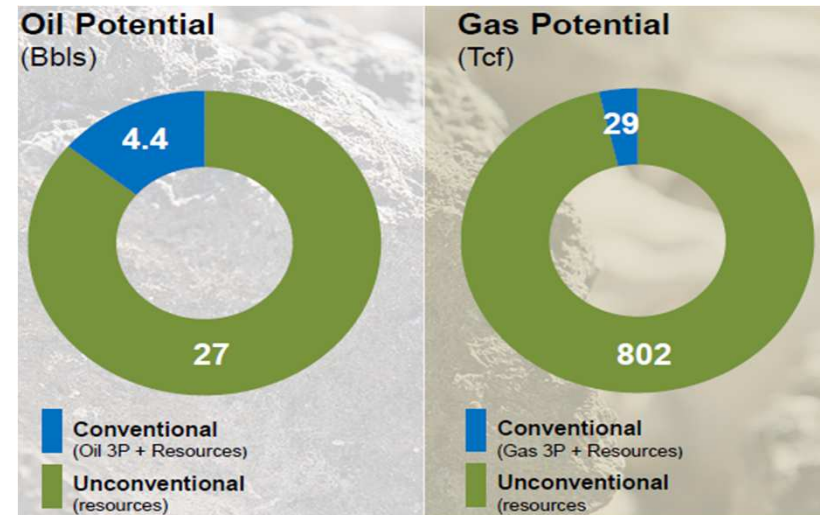
Index

- DI & Gas Energy Latin America presentation
- Background
- Overview of U.S. unconventional hydrocarbon development
- What is predictive modeling?
- What is grading acreage?
- What is sharing of information?
- How to use predictive modeling to grade the acreage to develop Vaca Muerta
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Argentina – Neuquén, Vaca Muerta



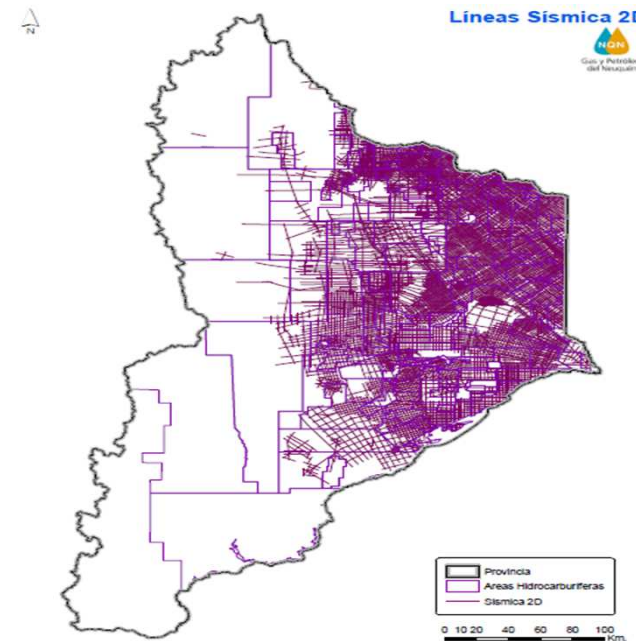
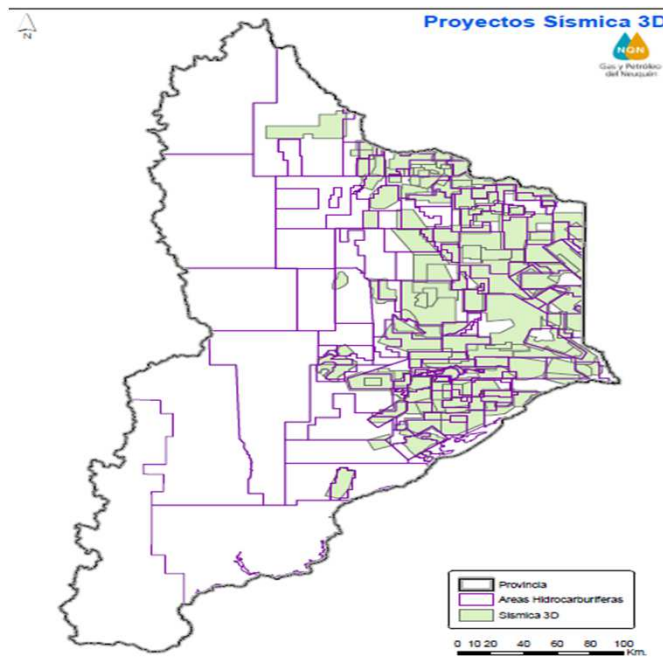
- Argentina – 2nd place behind China shale gas – 802 Tcf
- Neuquén Basin –Vaca Muerta shale leads way
- Loma la Lata Norte & Loma Campana most important sweetspots



Extensive Information for Vaca Muerta Play in Argentina

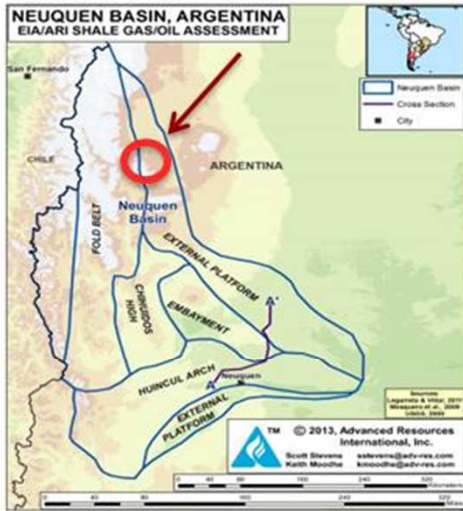
Even though the formation has not been exploited extensively yet using modern hydraulic fracturing technologies, the formation has been extensively penetrated for decades

- **Seismic Data – 2D Lines, 3D Blocks**



Vaca Muerta play in Argentina, has data for over 10,000 penetrations (well logs) and also extensive 2D and 3D data.

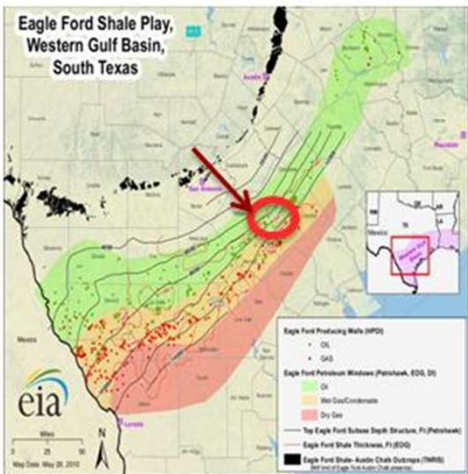
Geological analog to run predictive modeling to determine sweetspots and predict production



Obtención de información geológica

Basic Data	Basin/Gross Area	Neuquen (66,900 mi ²)						
	Shale Formation	Los Molles			Vaca Muerta			
	Geologic Age	M. Jurassic			U. Jurassic - L. Cretaceous			
	Depositional Environment	Marine			Marine			
Physical Extent	Prospective Area (mi ²)	2,750	2,380	8,140	4,840	3,270	3,550	
	Thickness (ft)	Organically Rich	800	800	800	500	500	500
	Depth (ft)	Interval	6,500 - 9,500	9,500 - 13,000	13,000 - 16,400	3,000 - 9,000	4,500 - 9,000	5,500 - 10,000
Reservoir Properties	Average	8,000	11,500	14,500	5,000	6,500	8,000	
	Reservoir Pressure	Highly Overpress.	Highly Overpress.	Highly Overpress.	Highly Overpress.	Highly Overpress.	Highly Overpress.	
	Average TOC (wt. %)	2.0%	2.0%	2.0%	5.0%	5.0%	5.0%	
	Thermal Maturity (% Ro)	0.85%	1.15%	2.20%	0.85%	1.15%	1.50%	
Clay Content	Low/Medium	Low/Medium	Low/Medium	Low/Medium	Low/Medium	Low/Medium		

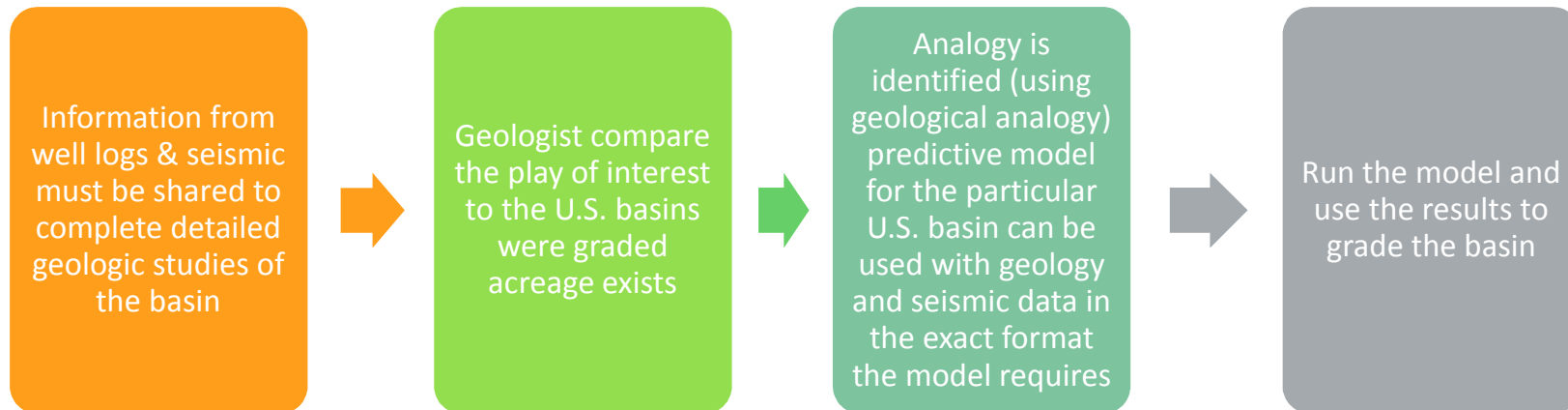
Analogía con roca conocida de similares propiedades



Estimación de recursos potenciales

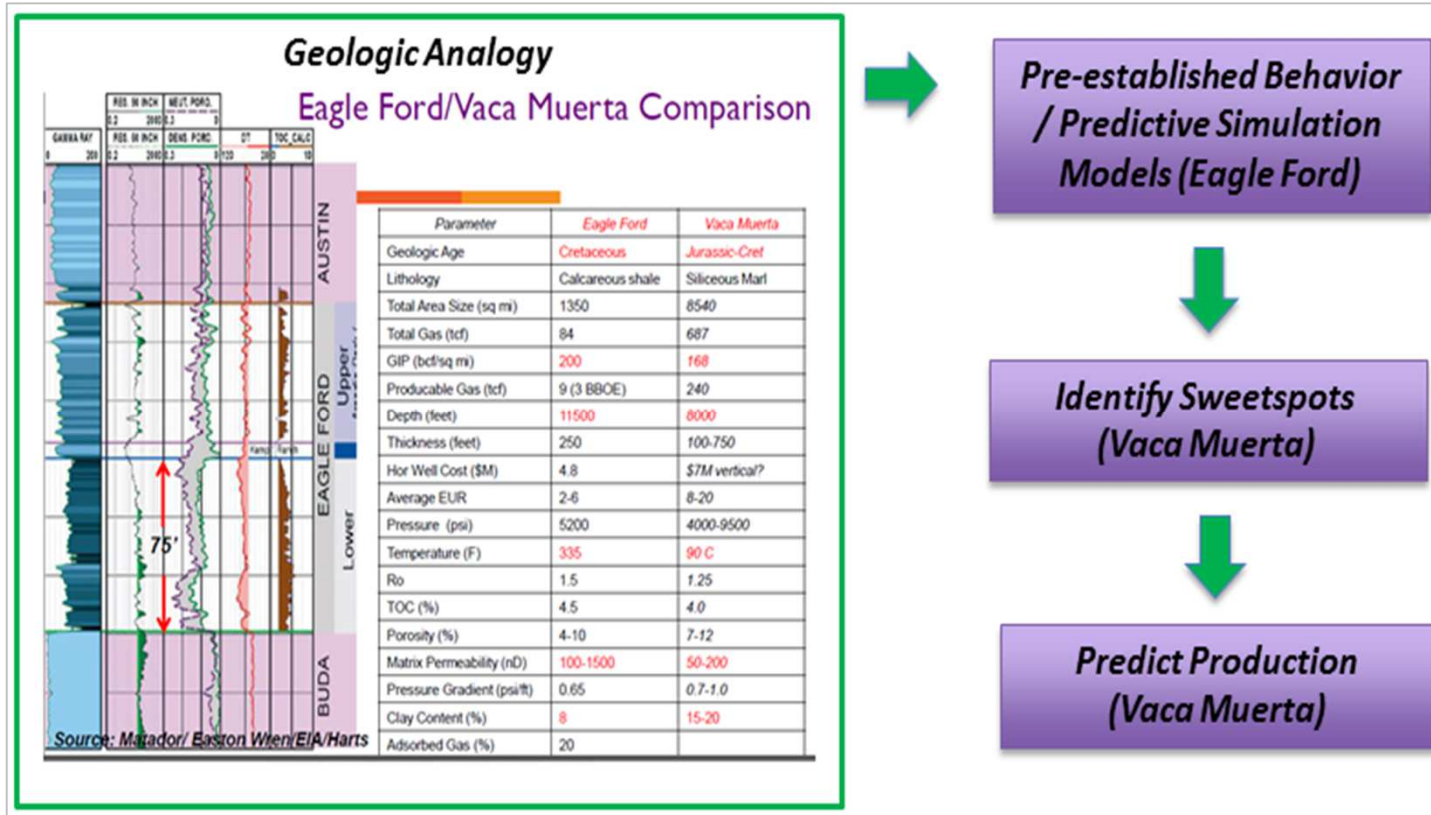
Resource	Gas Phase	Assoc. Gas	Wet Gas	Dry Gas	Assoc. Gas	Wet Gas	Dry Gas
	GIP Concentration (Bcf/mi ²)	49.3	118.0	190.1	66.1	185.9	302.9
	Risked GIP (Tcf)	67.8	140.4	773.8	192.0	364.8	645.1
	Risked Recoverable (Tcf)	8.1	35.1	232.1	23.0	91.2	193.5

Steps to to evaluate new unconventional plays in the U.S. and other plays of the world



- This is a beneficial technique because a vast amount of oil and gas production is not needed for the evaluation. It only requires geologic and/or seismic data.
- This will result on sweetspot determination and predictive production on the whole new play on or a determined area within a play.

Proposed process for the development of Vaca Muerta



If a U.S. analog is identified for the Vaca Muerta, the predictive model for the U.S. basin can be used to grade the Vaca Muerta and thereby improve the understanding of the entire basin, identify sweetspots, predict production and perform development optimization later in the development.

Index

- DI & Gas Energy Latin America presentation
- Background
- Overview of U.S. unconventional hydrocarbon development
- What is predictive modeling?
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- What is sharing of information?
- How to use predictive modeling to grade the acreage to develop Vaca Muerta
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Conclusions

- It is somehow imperative that other unconventional plays around other countries in the world, allow mechanisms to share information to get improved results and perform same type of analysis. This greatly improves rock productivity and benefits to companies and countries.
- Predictive modeling is a useful tool that allows you to grade an acreage to determine sweetspots, predict production and apply best practices to brake the rock. It is a valid scientific approach to achieve better and improved results in unconventional developments around the world.
- It is important to use as much data as possible but it has to be relevant data

THANK YOU



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