

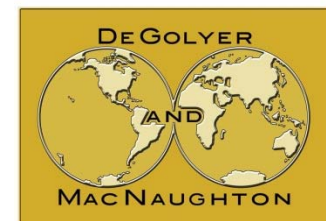
CBM Resource-Reserve Assessment

Perspectives for Well Performance Analysis and Forecasting
for CBM

DeGolyer and MacNaughton

September 29, 2020

International Webinar on CBM
Resource-Reserve Assessment



Worldwide Petroleum Consulting

Introduction to DeGolyer and MacNaughton

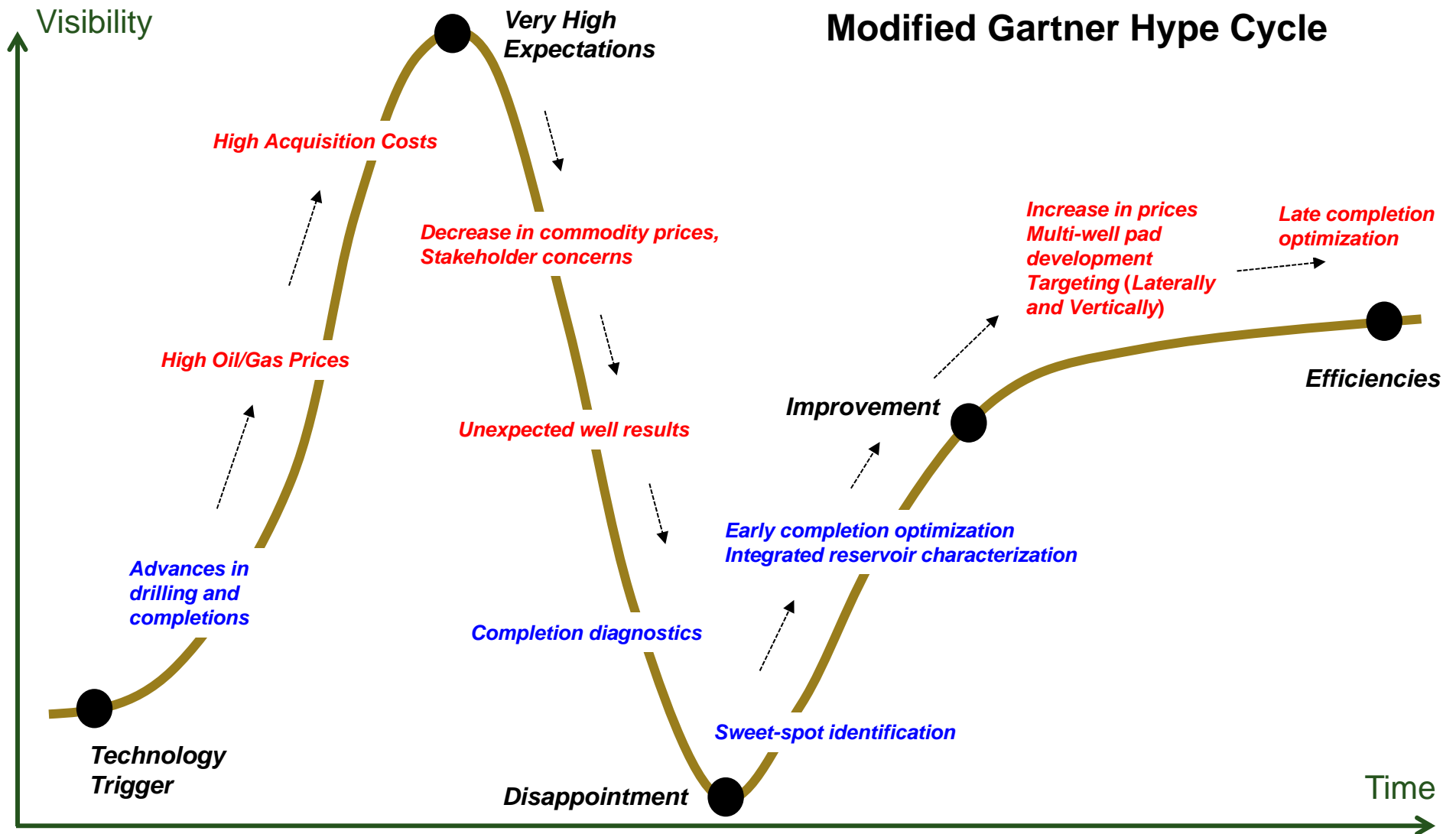
D&M is a large consulting firm dedicated to client services in oil and gas worldwide

- Established in 1936
- Largest independent petroleum consultant in the world
 - Worldwide professional staff of over 250
 - Offices in multiple geographic areas: Dallas headquarters
- Completely independent entity
 - Employee owned
- Experience in more than 100 countries and virtually every basin in the world
 - Our regional structure ensures that our clients will be assigned technical teams that understand the petrophysical, political, and economic challenges that exist in the region
 - India – Major clients
 - BP, Cairn India, DGH, ONGC, Oil India, Reliance, Sun Petro
- Industry leader in reserves and technical evaluations



“Progression Cycle” for Unconventionals

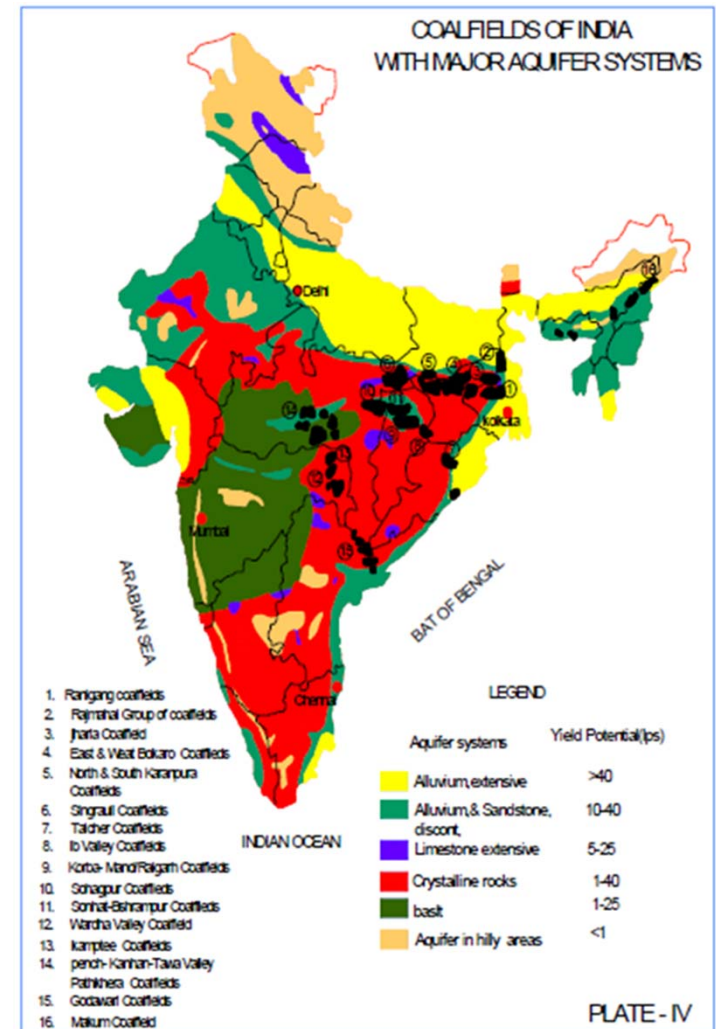
Progression cycle schematic illustrates typical North America unconventional development



Coal Bed Methane in India

India has large coal resources and encouraged CBM development to help meet future needs

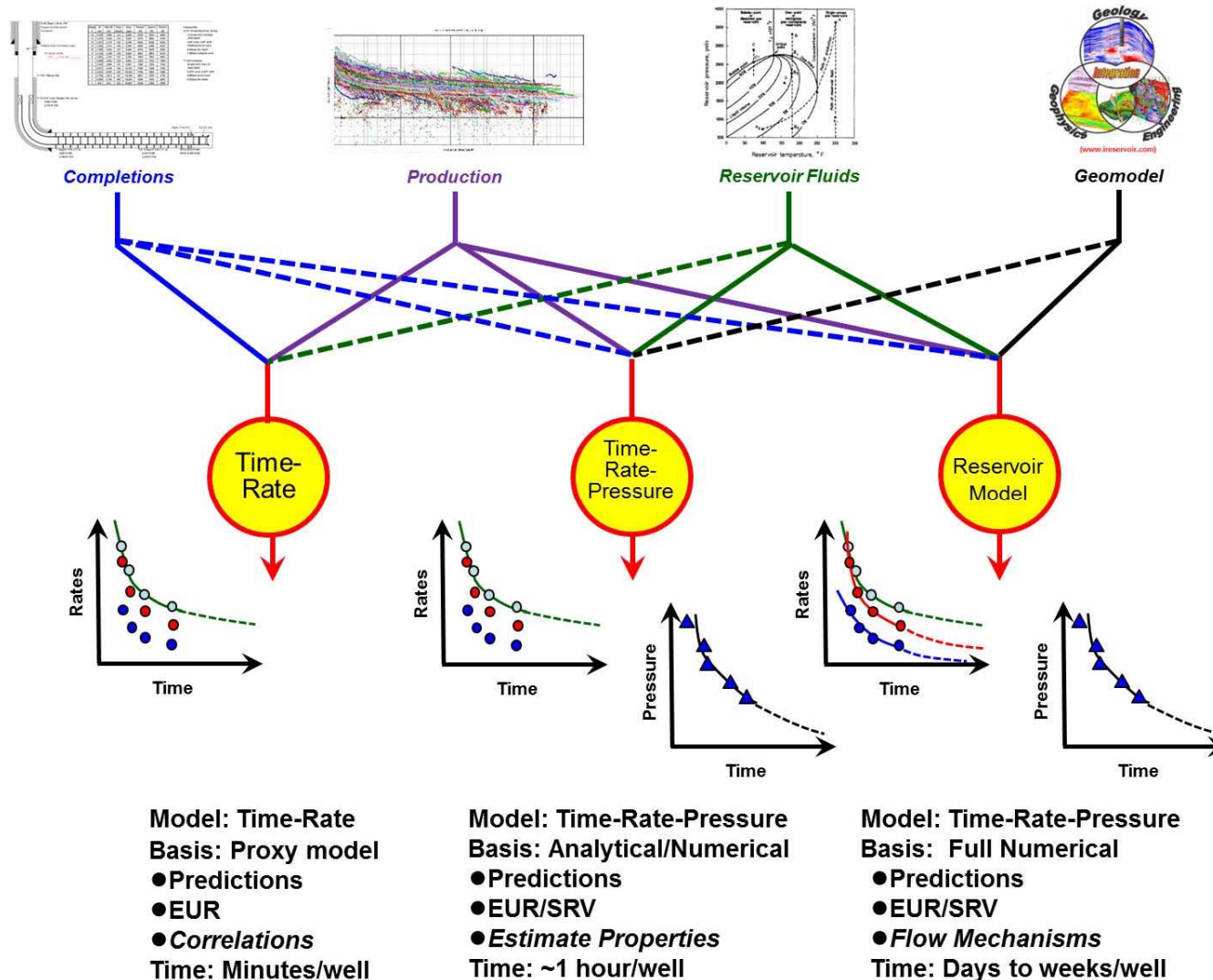
- India's coal resources ~ 319 billion metric tons
 - Over 99% of this coal found in Gondwanan basins associated with Permian fluvial deposits (especially the Lower Permian Barakar Formation)
- CBM development
 - Coal deposits suitable for CBM extraction are identified based on suitable areal extent, depth, thickness, gas content, and permeability (cleat system)
 - Regulatory framework was established in 1997. First commercial production was in 2007.
 - Total estimated CBM resources in India (DGH) of around 2.6 trillion cubic meters (TCM)
 - To date, 33 CBM license blocks have been awarded, representing about 1.8 TCM. These blocks are at various stages of development, with development-stage production from Raniganj and Sohagpur blocks



A. Mohan, CMPDI

Well Performance in Unconventional Reservoirs

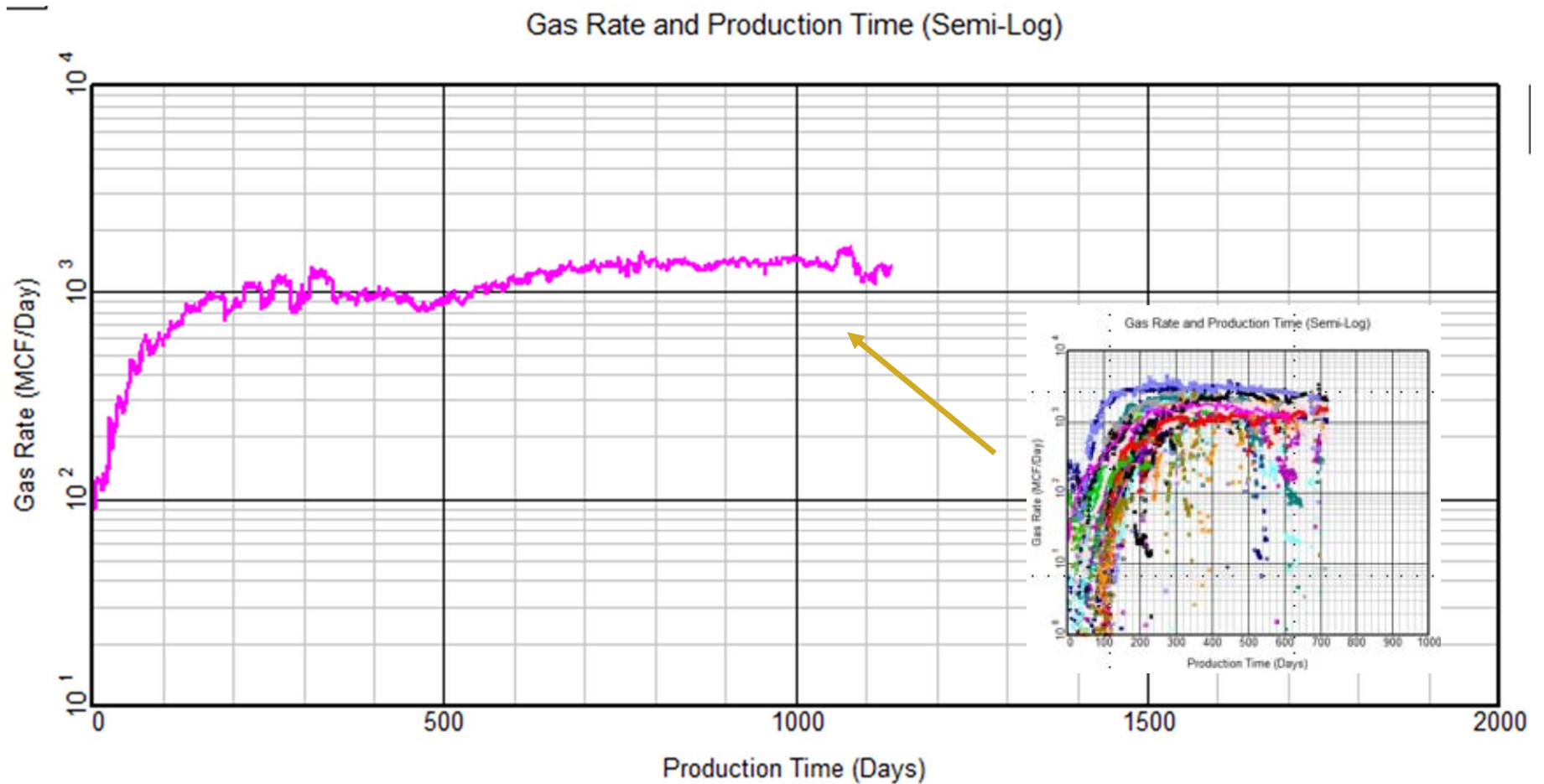
Utilization of methodologies are mainly related to business objective and data availability



Reference: T. Blasingame (Texas A&M)

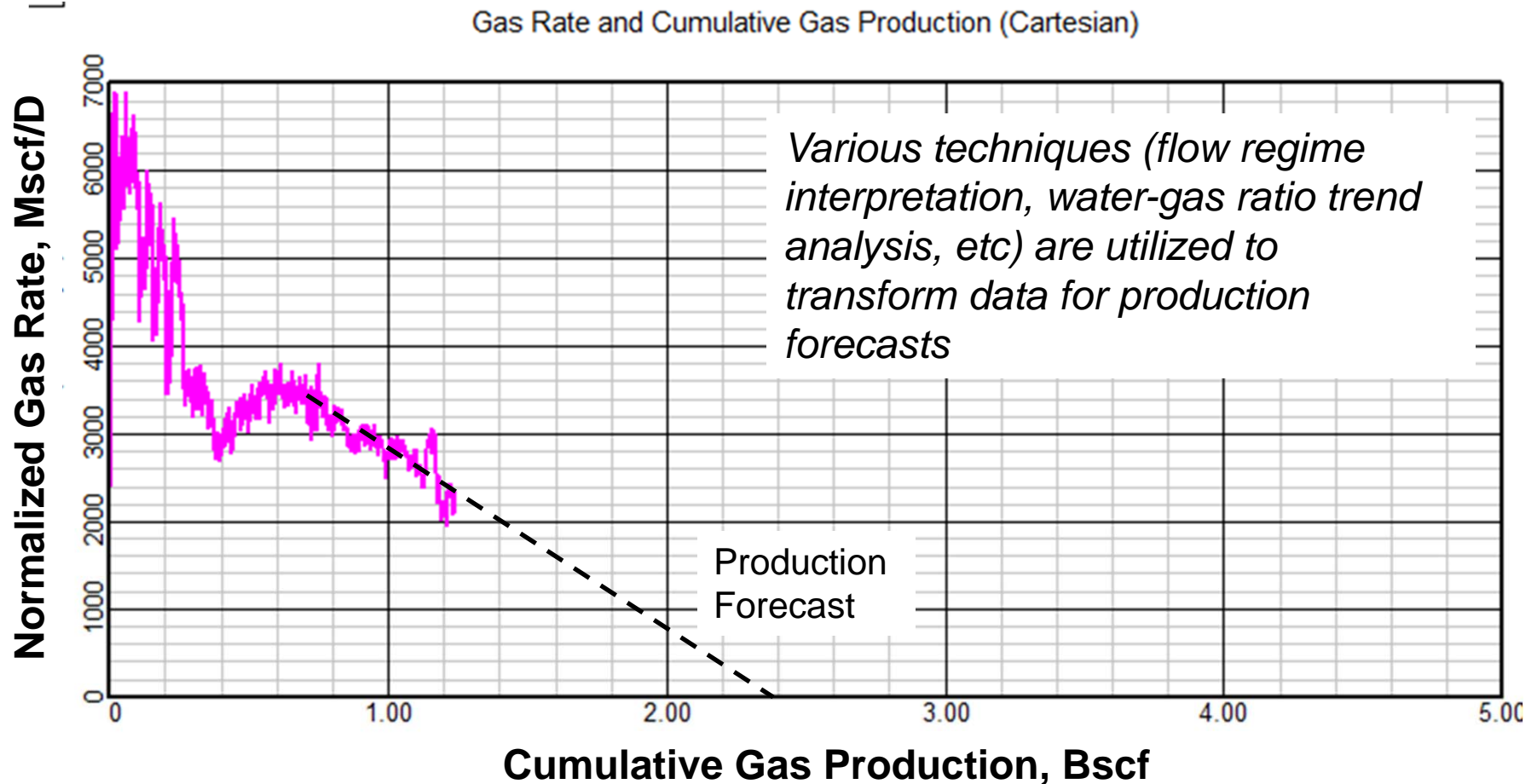
Diagnostic Techniques for CBM Reservoirs

Typically CBM wells do not exhibit apparent decline behavior posing a major challenge



Diagnostic Techniques for CBM Reservoirs

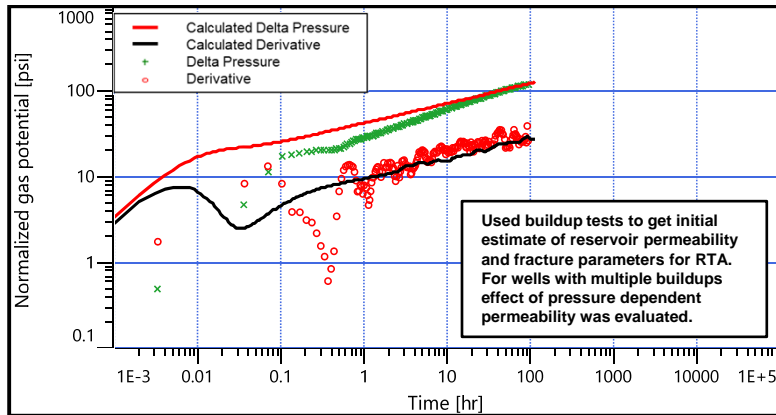
Empirical methodologies assist with production forecast when there is no decline behavior



Rate-Transient Analysis for CBM Reservoirs

Rate and pressure data, reservoir and fluid properties, well history are required for analysis

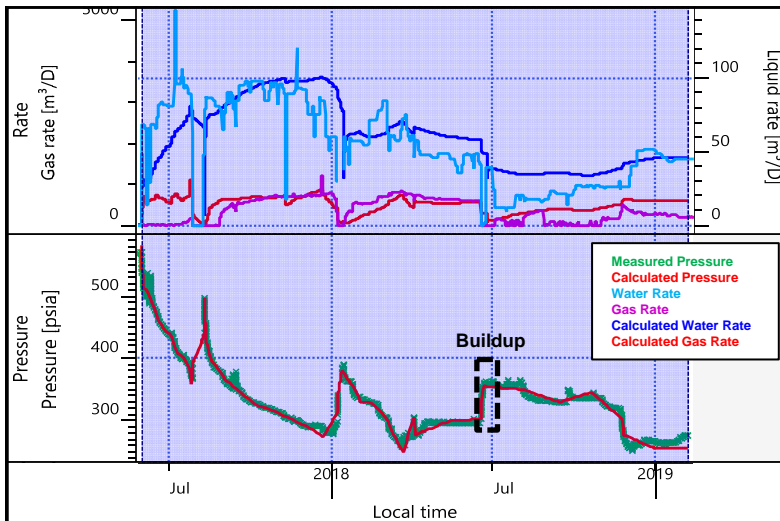
**PRESURE TRANSIENT ANALYSIS (BUILDUP ANALYSIS)
AUTOMATIC TYPE CURVE MATCH**



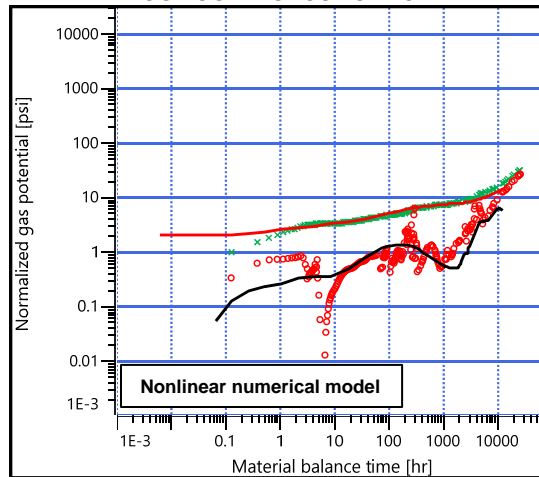
Input for RTA from PTA

RATE TRANSIENT ANALYSIS

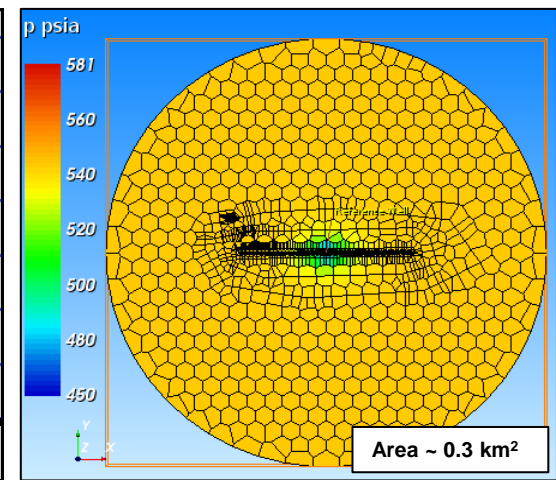
INPUT PERFORMANCE DATA and CALCULATED RATES and PRESSURE



**RATE TRANSIENT ANALYSIS
LOG-LOG DIAGNOSTIC PLOT**



PRESSURE DISTRIBUTION FROM RTA

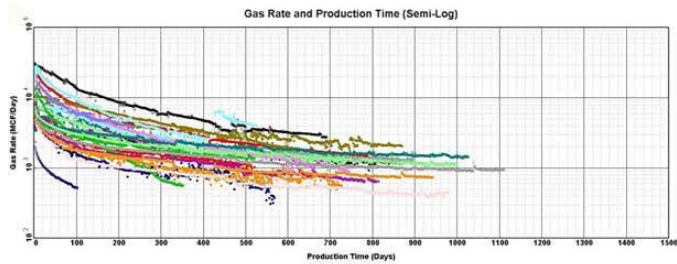


- "Model-Based" Analyses: Using analytical/numerical reservoir models to perform simultaneous analysis/modeling procedures. RTA provides estimates of
 - Flow capacity (kh)
 - Permeability and pressure-dependent permeability
 - Boundary character
 - Larger radius of investigation may provide additional insight for boundary character compared to individual buildup tests
 - Drainage area
 - Well properties (fracture parameters, skin)
 - Changing Productivity
- "Model-Based" Forecasting: A direct extension of model-based analysis — generation of a time-dependent pressure and/or rate forecast.

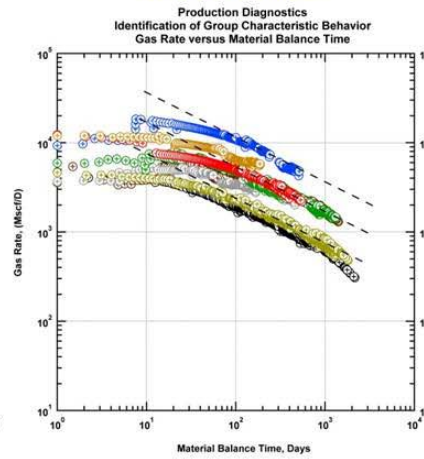
Performance Based Methodology

Challenges associated with CBM production forecasting warrants use of integrated methods

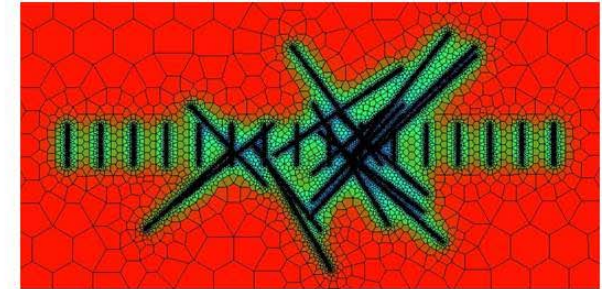
REVIEW



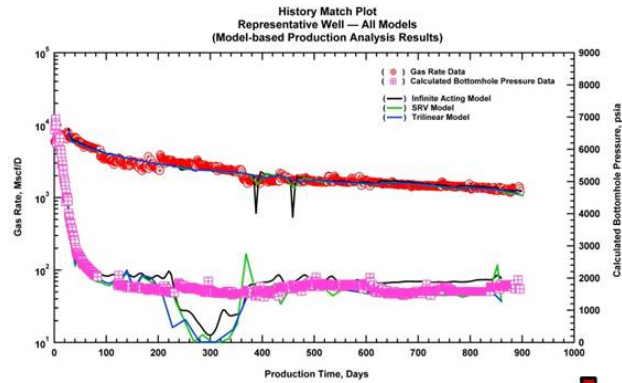
DIAGNOSIS



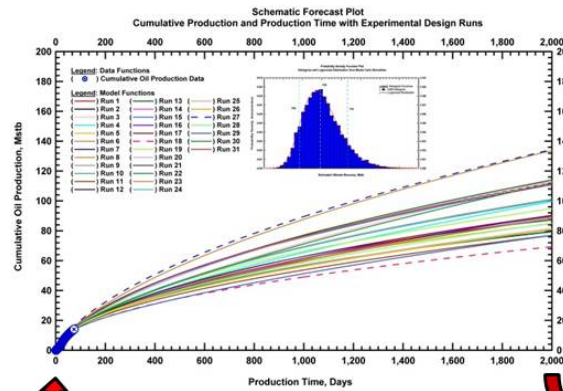
MODELING



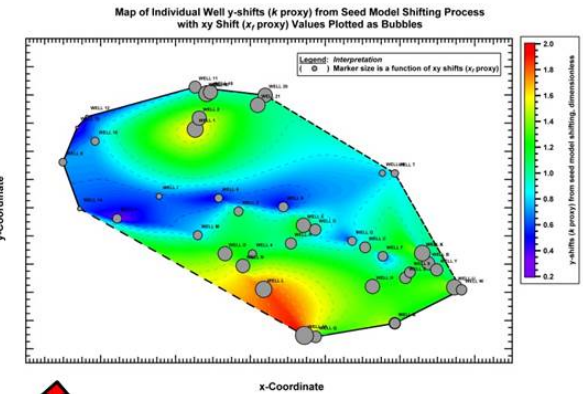
ANALYSIS



FORECASTING



INTEGRATION



Well Performance in Unconventional Reservoirs

Consistent field performance analysis workflow yields critical deliverables

