Application of Data Driven Analytic Techniques for Optimizing Future Production in Marcellus Shale, Case Study of Southwestern Pennsylvania

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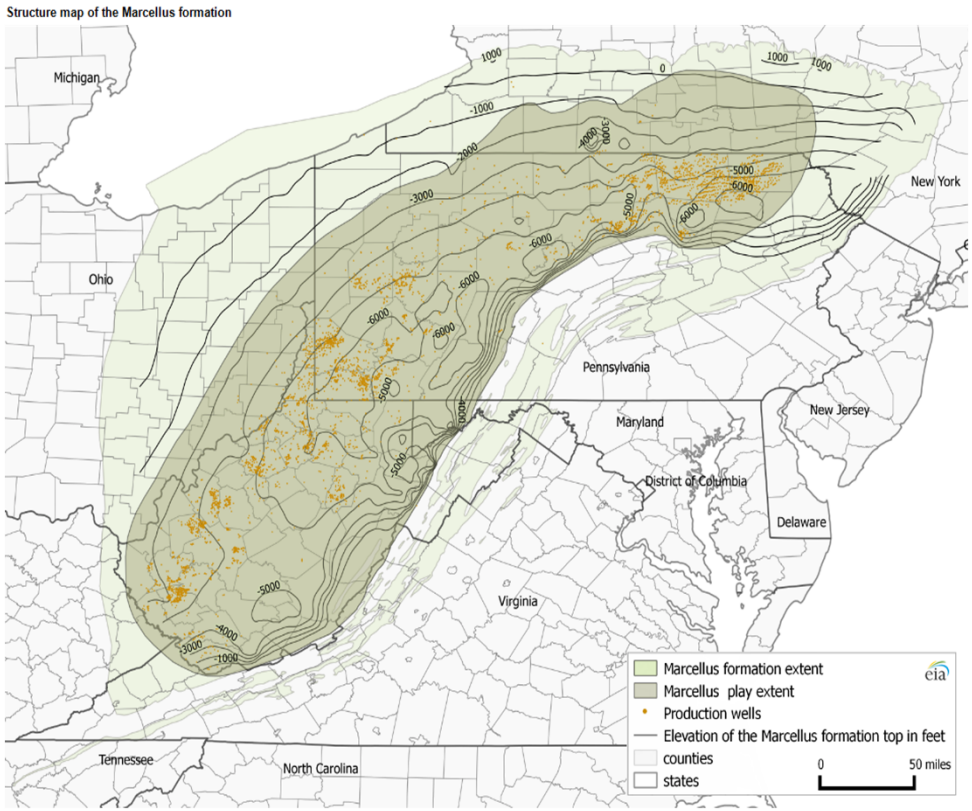
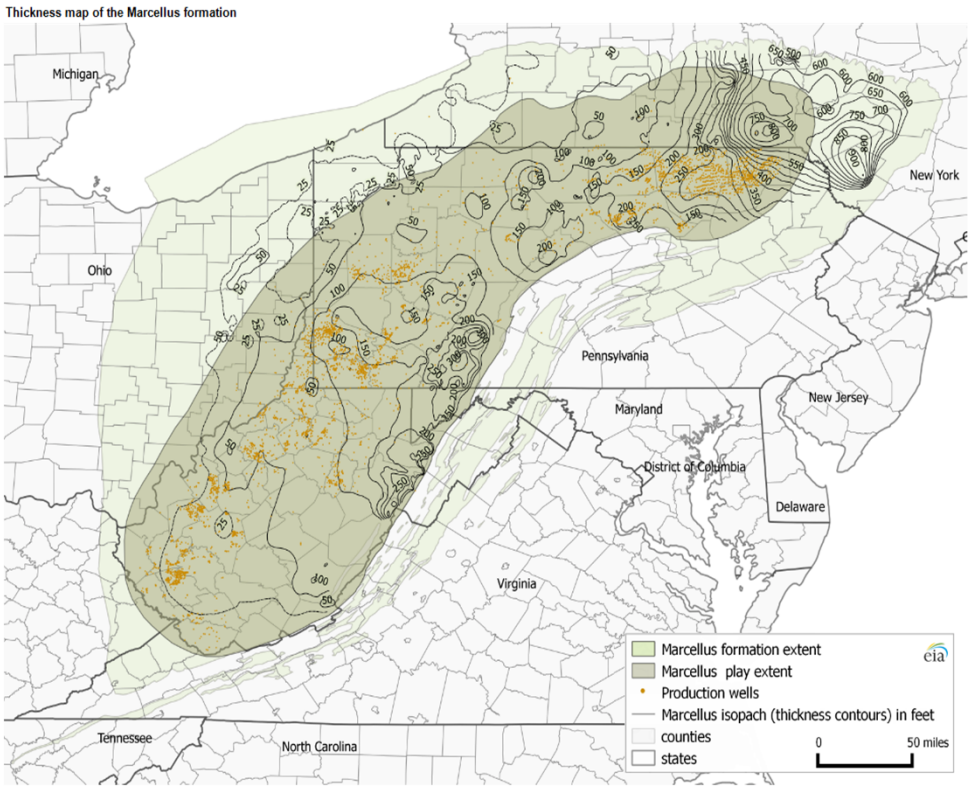
Based on SPE papers 187505 & 191827

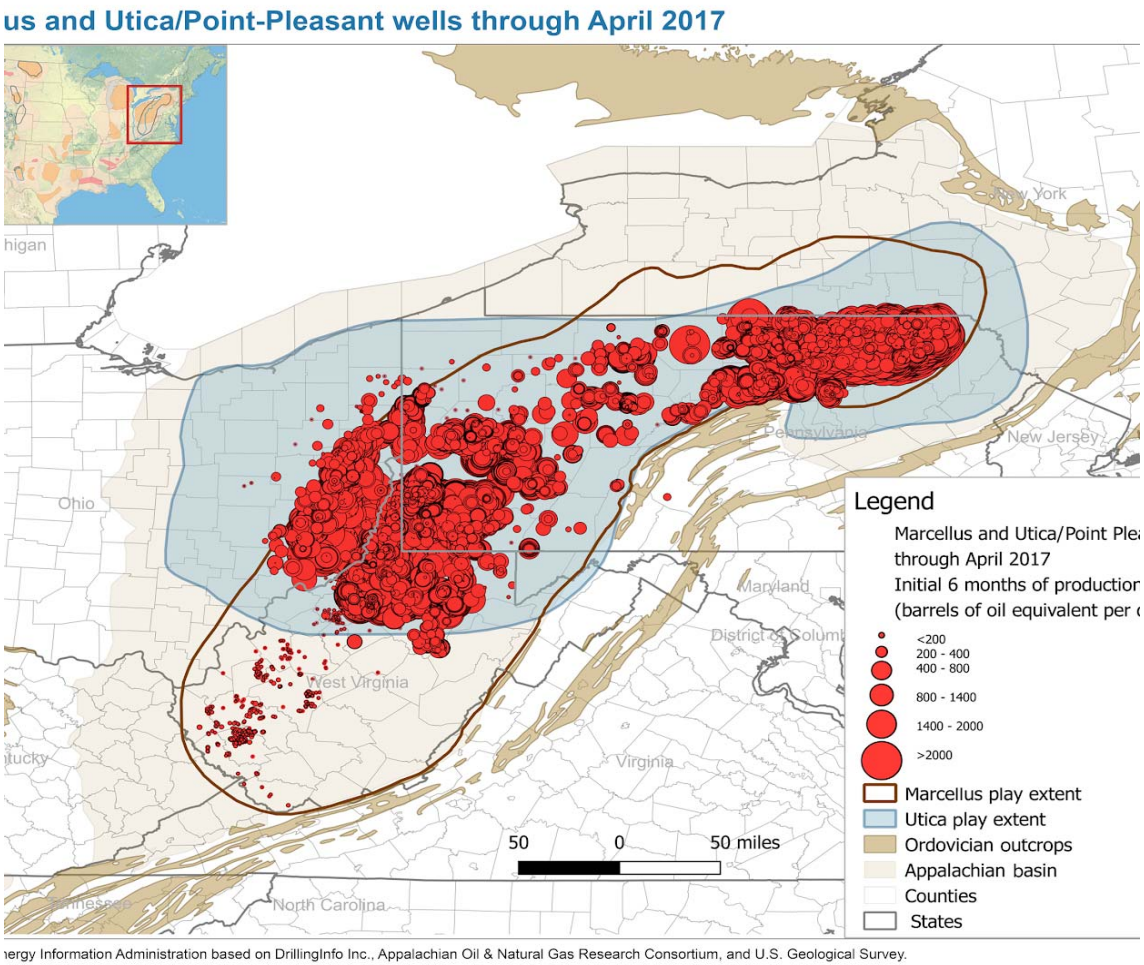
Overview

- Introduction/Objective
- Workflow
- Geologic Model
- Well Database
- Machine Learning Algorithms
- Results
- Concluding Remarks

EIA Thickness & Structure Maps



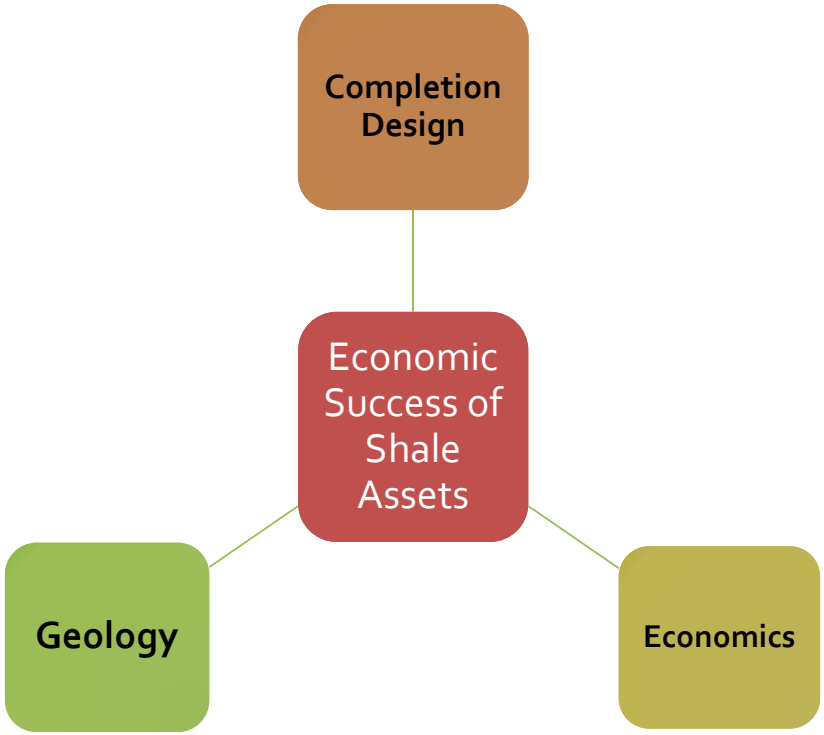




EIA Production Map

- Marcellus Shale has about a decade development history.
- According to EIA (2016) Marcellus Shale has the proved reserve of 84.1 trillion cubic feet.
- The two extremely prolific and active areas of Marcellus Shale are the NE and SW of PA.
  - High Total Organic Carbon
  - Thick (150-200 ft)

How Do We Increase Our Success?



This study focus on refining the completion design, via geologic modeling and data analytics, in order to accurately forecast well performance in order to provide solid economic evaluations.

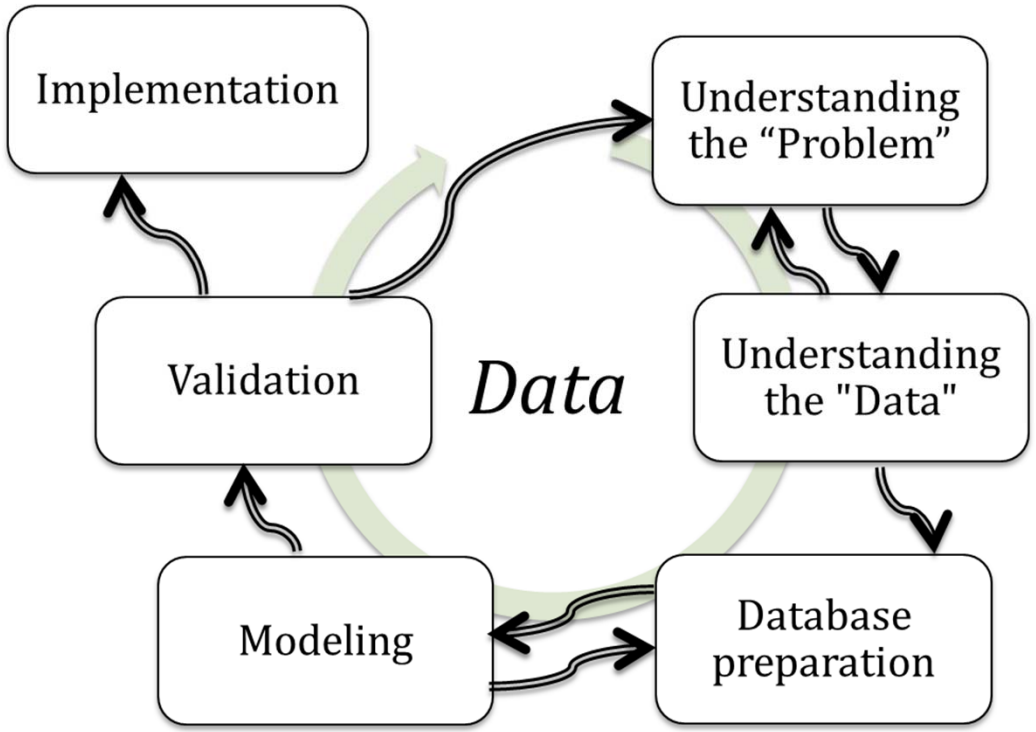
Why Utilize Machine Learning?

- Reservoir Simulation & Geologic Modeling
  - Computationally expensive; time-consuming
  - Biased physics
  - Unable to perform full-field modeling
- Data-driven models
  - Unbiased
  - Computationally cheap

Objective

Develop and validate predictive models using machine learning algorithms for the Marcellus Shale in southwestern PA.

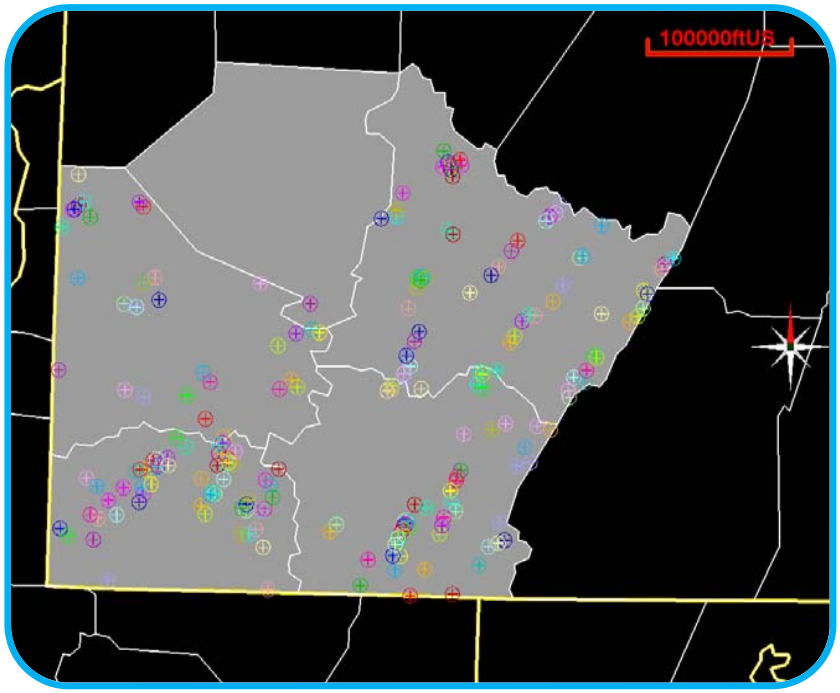
Employ the models in reservoir management decision making in order to answer questions about the best infill drilling scenarios, optimum hydraulic fracturing design, estimated initial production rate, and estimated ultimate recovery.

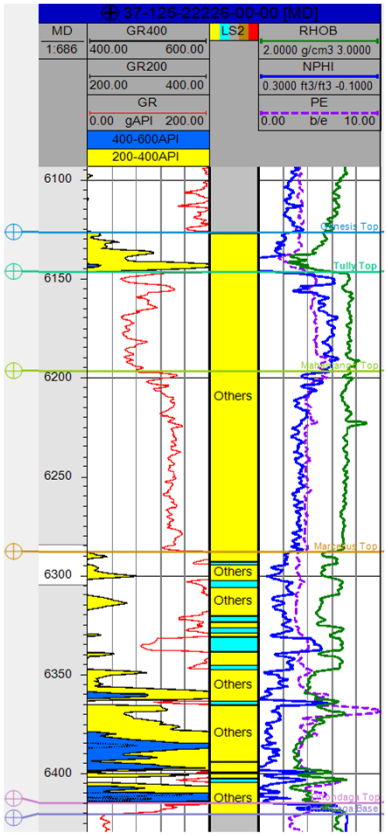


DATA DRIVEN WORKFLOW

The "Problem"

- The Problem: Estimated Ultimate Recovery (EUR)
- EUR value for a well is known to be directly impacted by the reservoir quality, drilling/completion design, relative location, and initial well performance.
- The EUR values in the database were estimated using Decline Curve Analysis (DCA) using "b" value of 1.2 and 6% terminal decline over 50 years

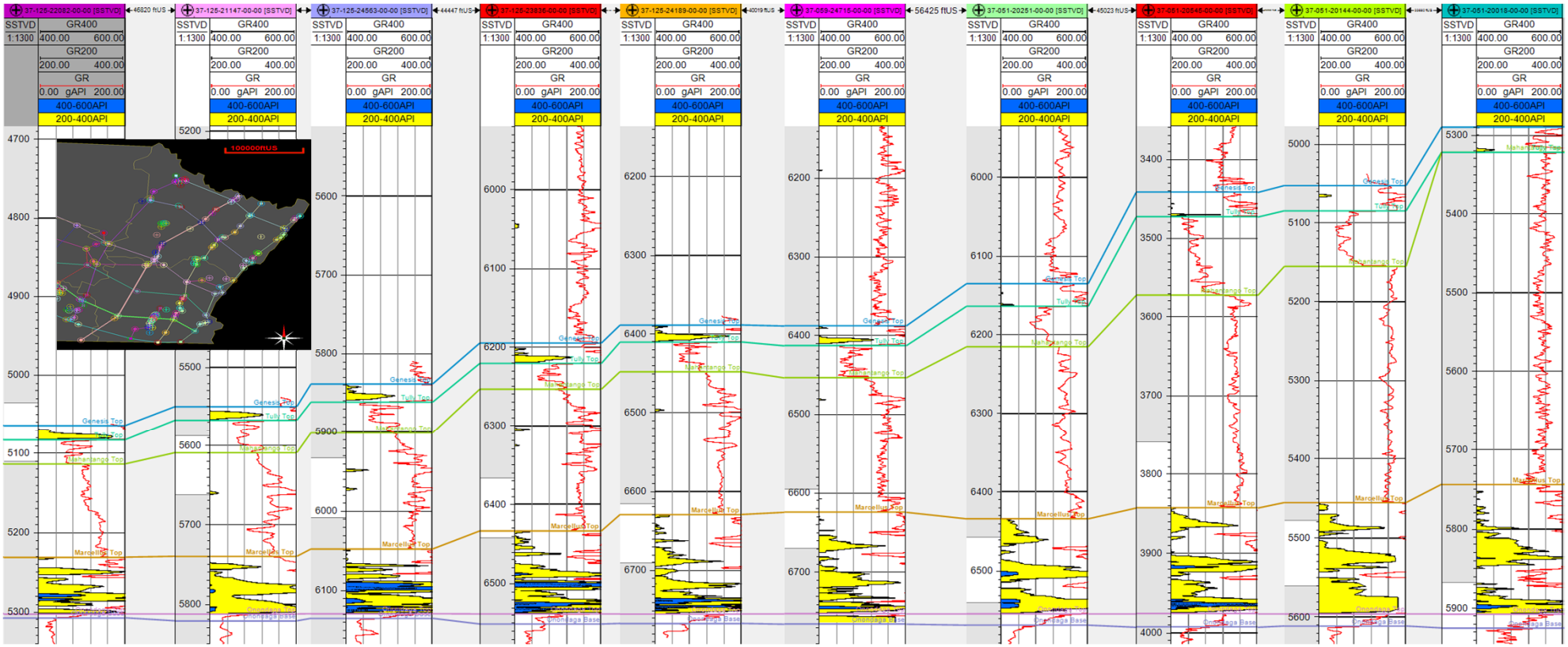




- 228 Well logs were used to characterize the thickness of Marcellus Shale and Purcell Limestone layers.
- Most of the logs are compiled from EDWIN database, DCNR, PA
- Gamma Ray, Density, Neutron, and PE logs were used.

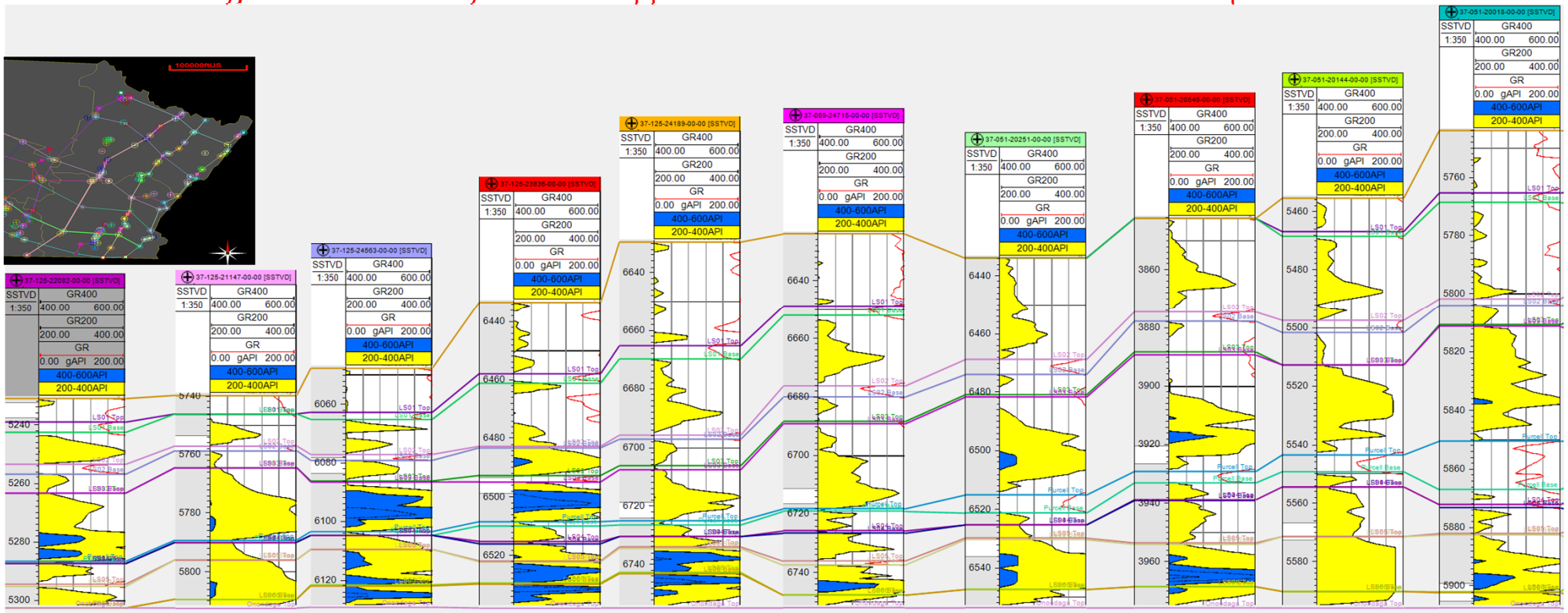
Understanding the Problem → Understanding the Data → Database Preparation → Modeling → Validation → Implementation

The major stratigraphic formations (such as Tully, Manhantango, Marcellus, Onondaga) were first picked.



Understanding the Problem → Understanding the Data → Database Preparation → Modeling → Validation → Implementation

Then, Purcell Limestone top and base were picked to subdivide Marcellus Shale to Upper Marcellus and Lower Marcellus. Finally, limestone interlayers within Upper Marcellus and Lower Marcellus were interpreted.



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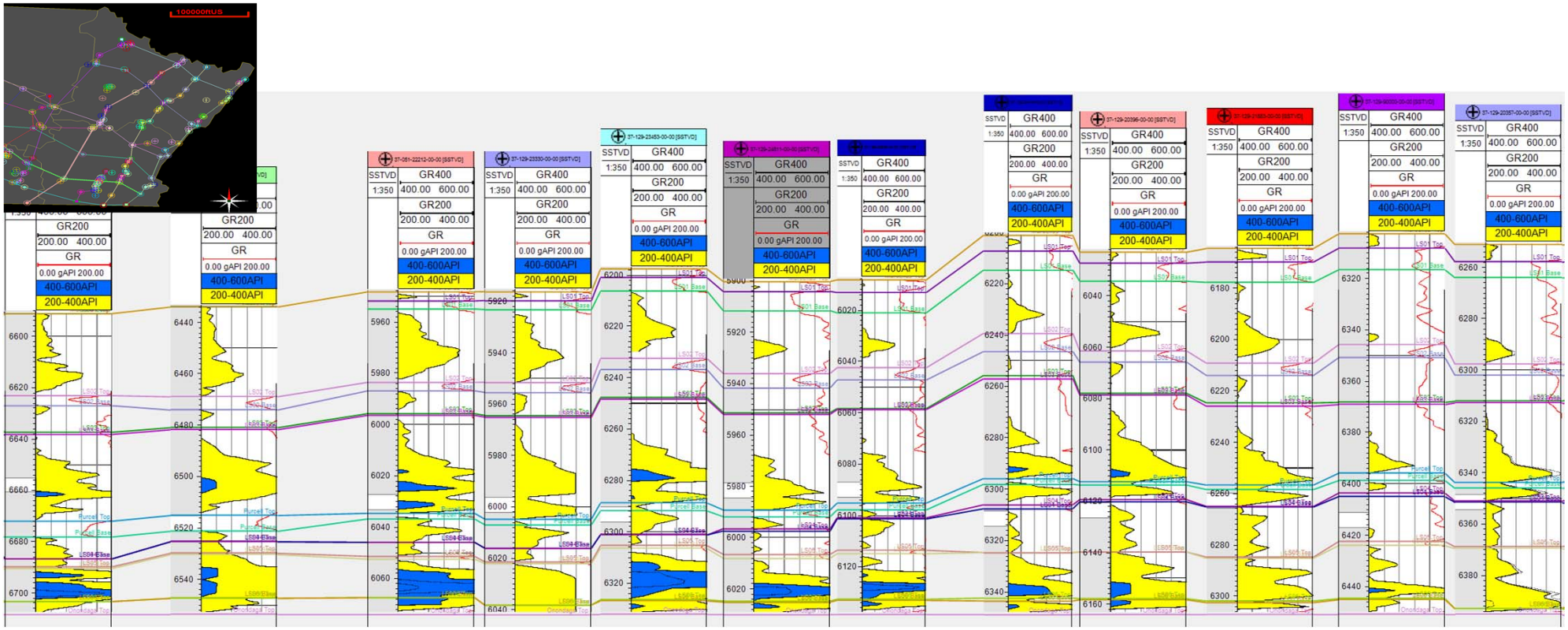

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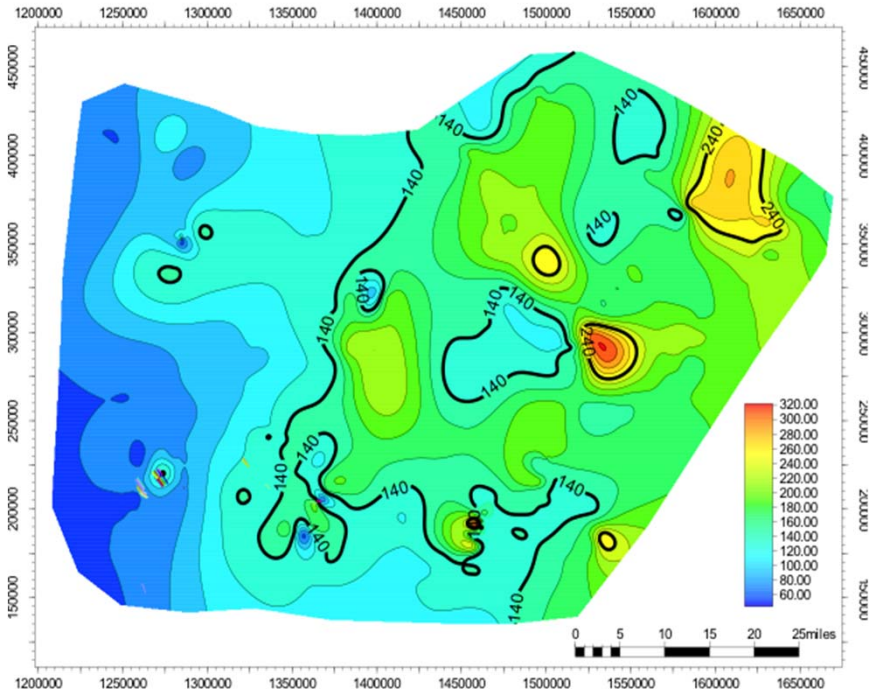
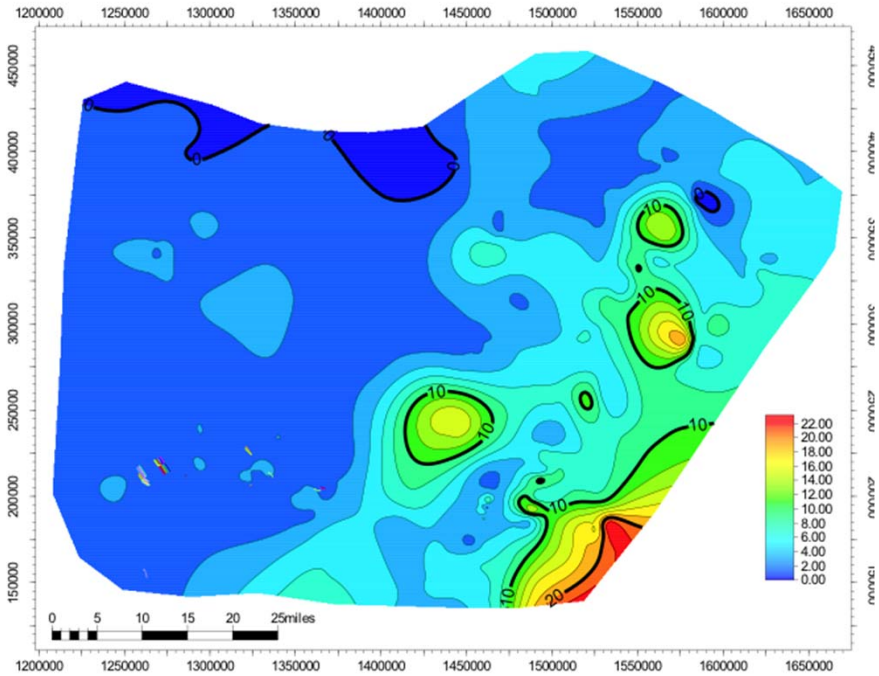
Average Marcellus Shale gross thickness for the study area



Purcell Limestone thickness for the study area



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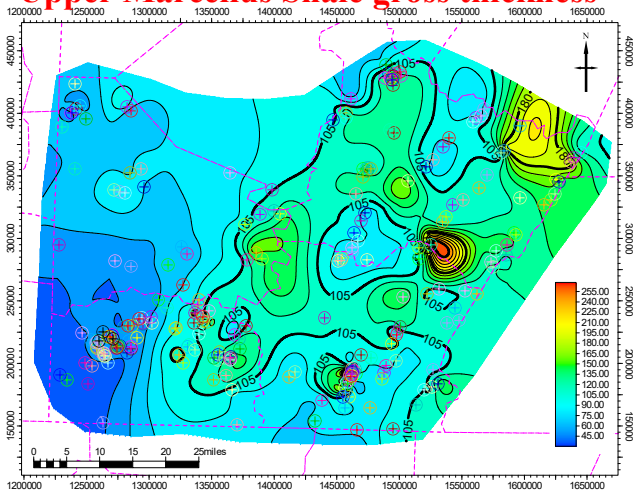
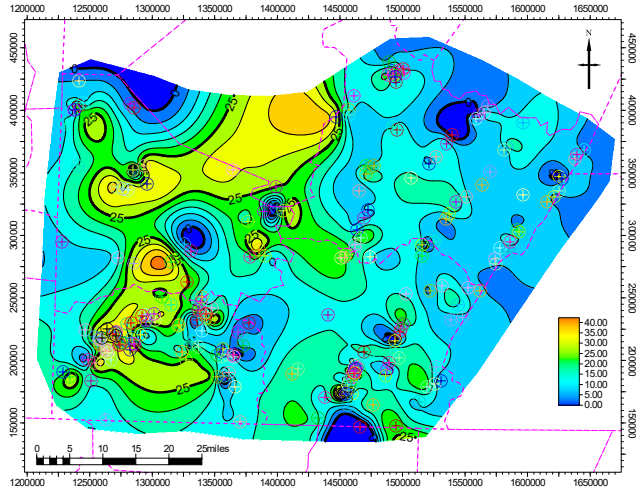
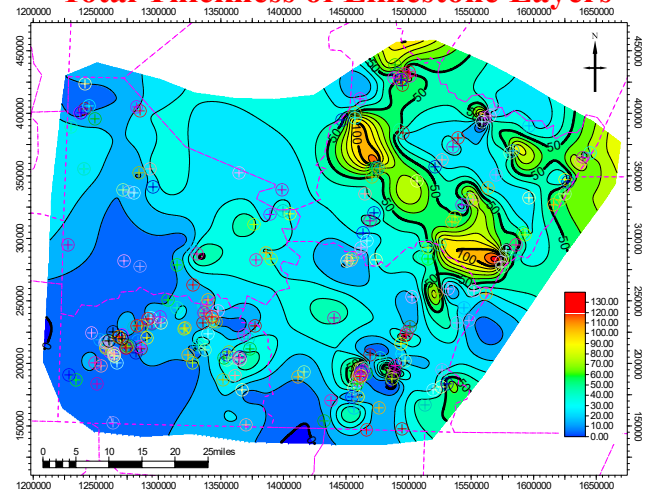
Upper Marcellus Shale gross thickness



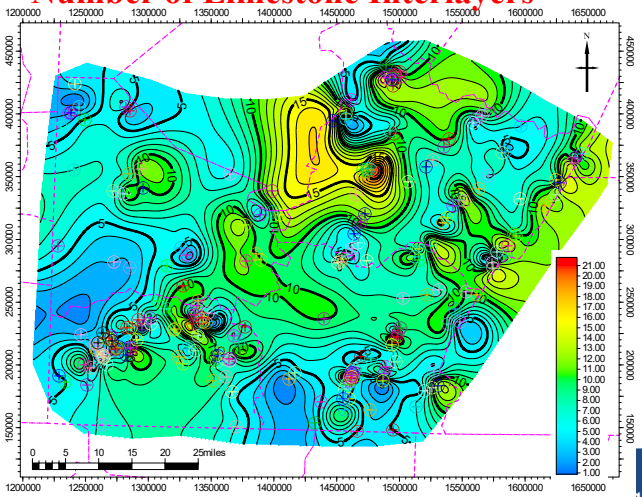
Marcellus Shale >400API thickness



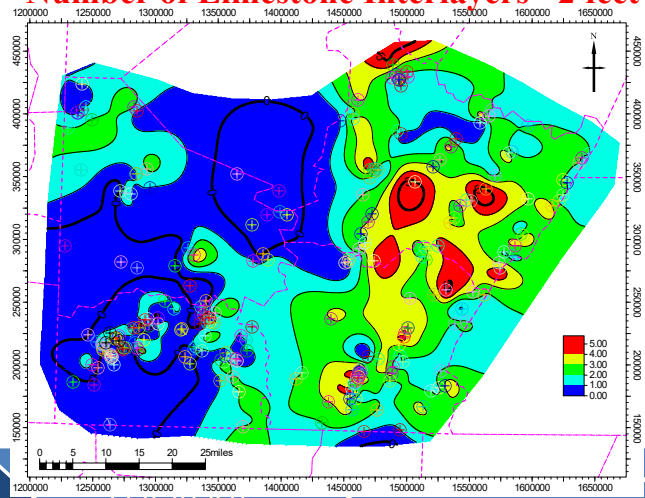
Total Thickness of Limestone Layers



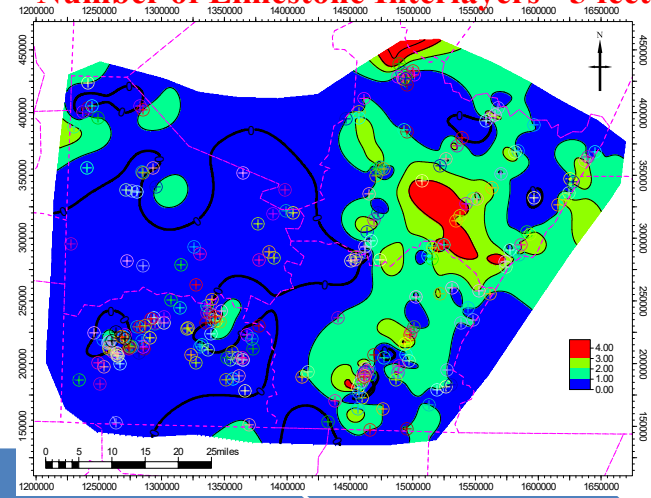
Number of Limestone Interlayers



Number of Limestone Interlayers >2 feet



Number of Limestone Interlayers >5 feet



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