AAET
ADVANCED ANALYTICS & EMERGING TECHNOLOGIES

Deployment of a Cloud-Based Deep Learning Model for Well Log Correlation at Scale

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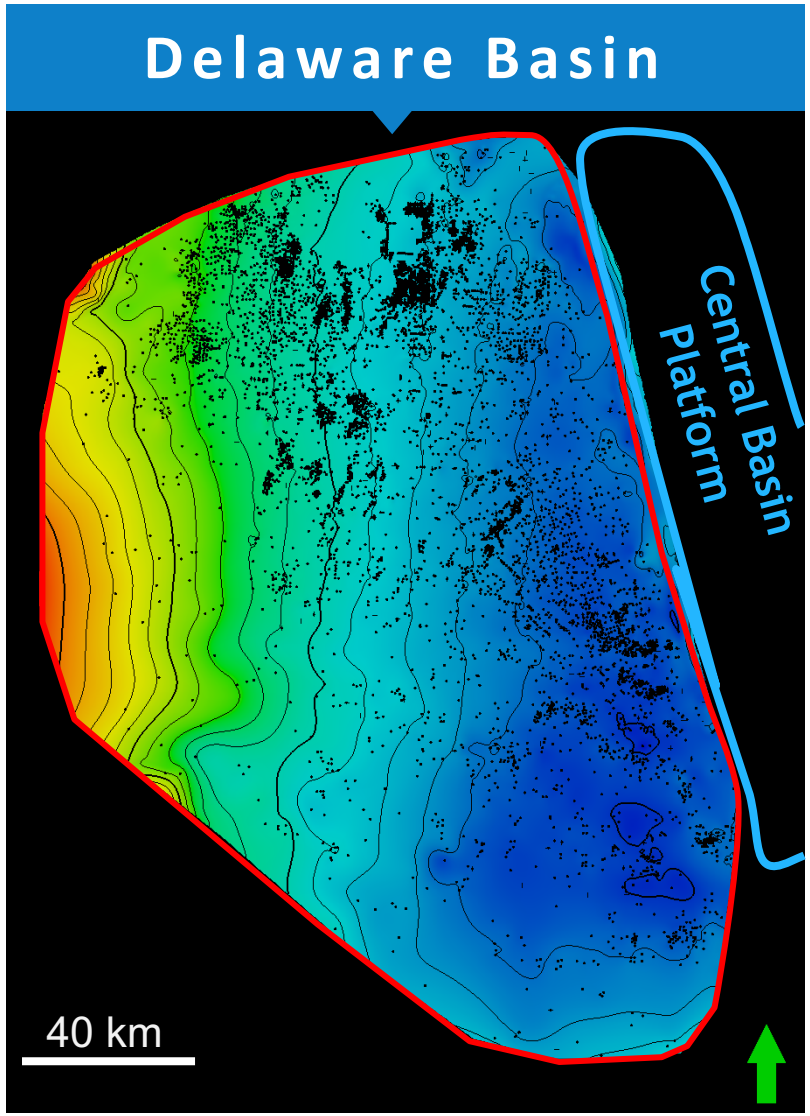
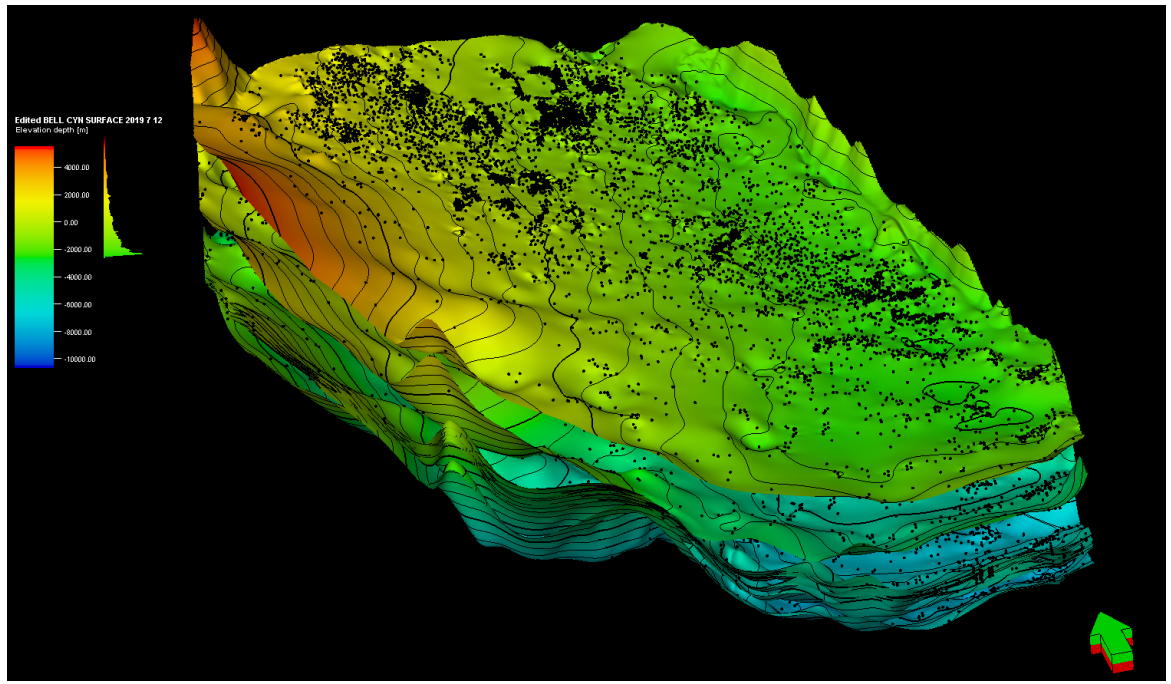
Generating Robust Stratigraphic Frameworks



Total Wells Correlated	Total Tops Interpreted & QC'd	Total Time
9,000+	30,000+	20 Days

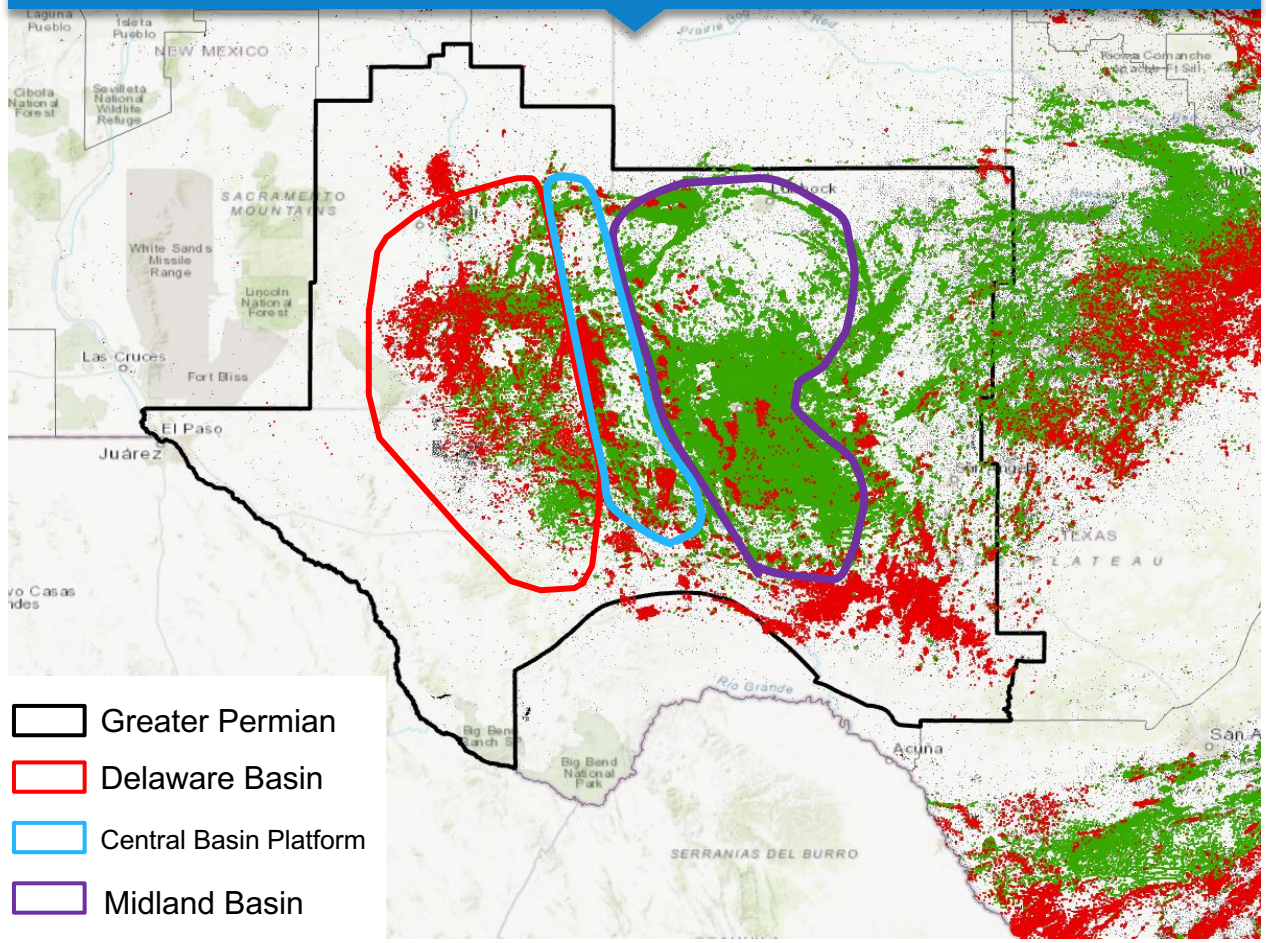


Scalable Solutions to Reduce Subsurface Uncertainty

How do we efficiently harness all available data to generate robust subsurface models?

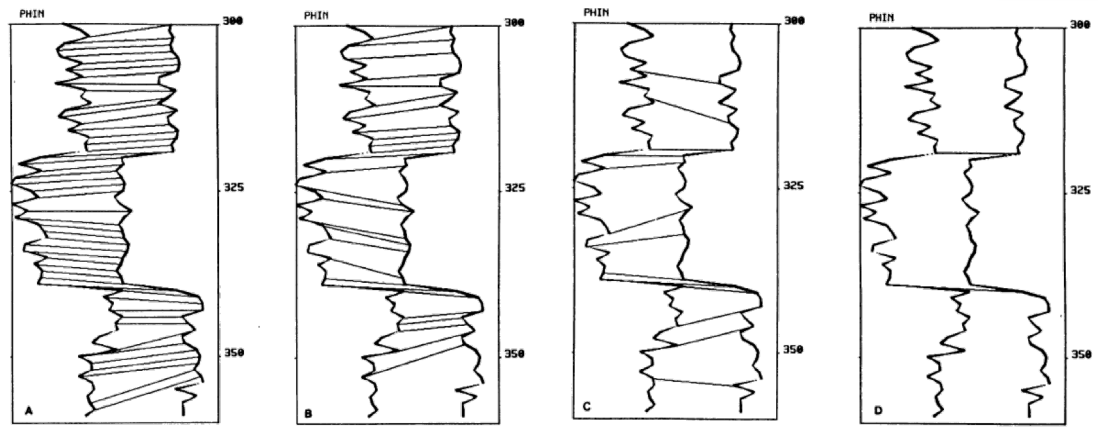
- Interpreter-driven, machine-assisted solution for high-density datasets
- Propagates defined markers w/ advanced deep learning algorithm & standard correlation techniques
- Objective, repeatable, scalable
- Actively deployed in exploration and development assets

Data from 100,000s Vertical Wells

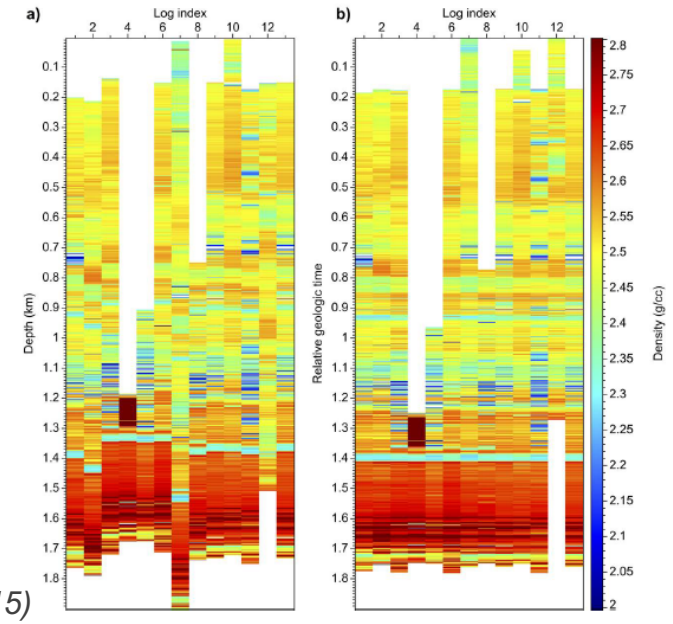


Existing Approaches to Well Log Correlation

- **Well log auto-correlation attempted since 1970's**
- **Resurgence in interest**
  - Improved computing
  - Onshore unconventional plays with 1000's – 10,000's of wells
- **Major limitations to existing approaches**
  - Computationally too intensive
  - Restricted to a defined cross-section
  - Drift with distance
  - Get 'lost' at faults/facies changes
- **Existing approaches are too rigid…**



(Lineman, 1985)

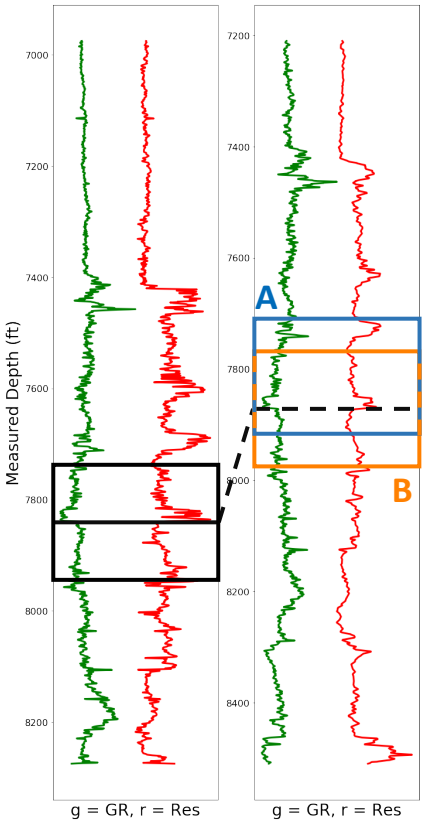


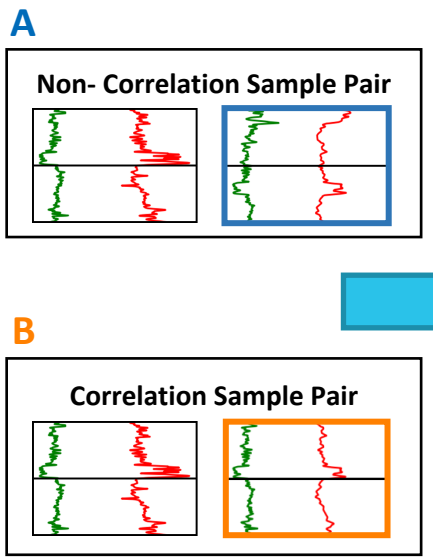
(Wheeler, 2015)

Leveraging Artificial Intelligence

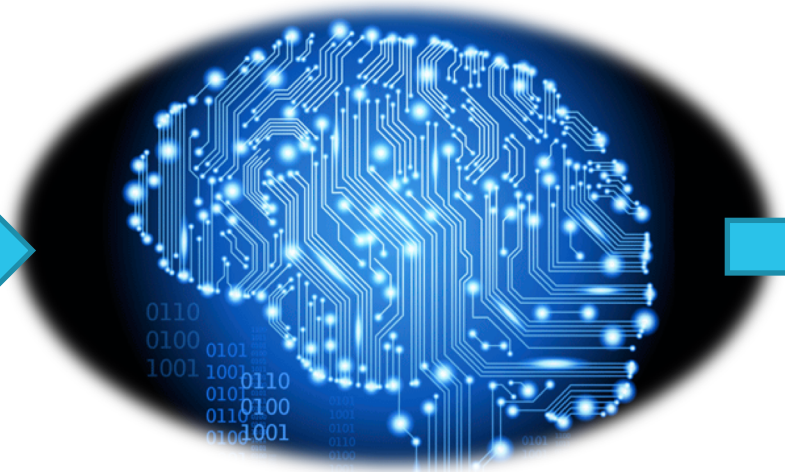
- **Machine Learning:** algorithms that perform a specific task without explicit instructions

6+ Million Samples





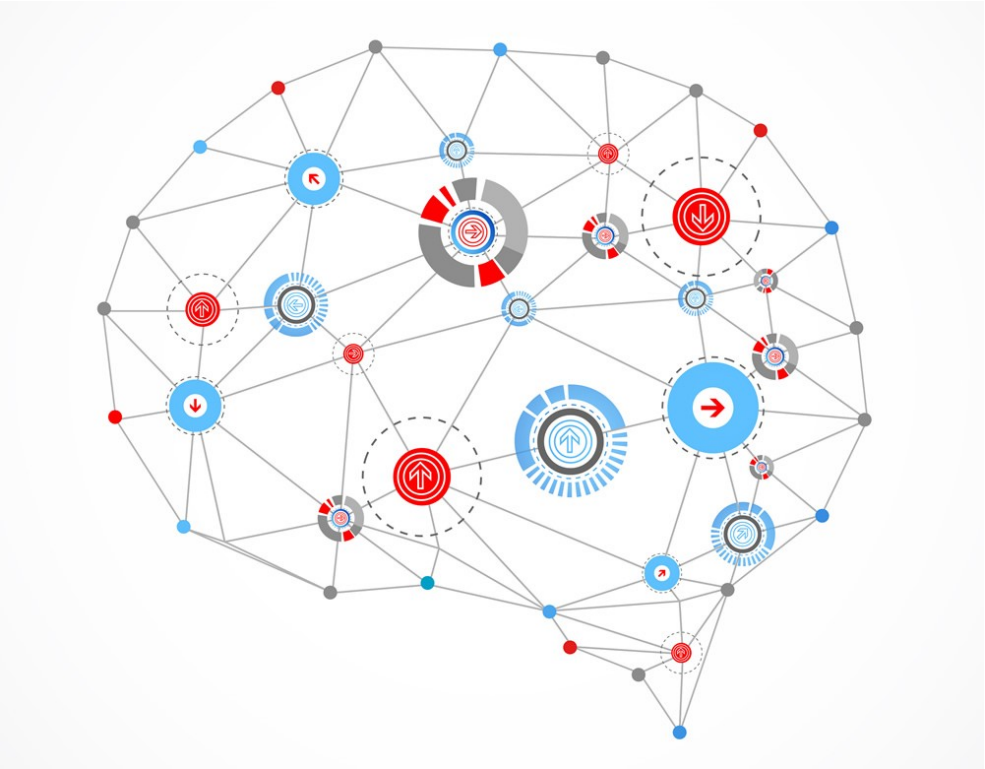
Deep Convolutional Neural Network Architecture



Quantitative Match Probability

Next-Gen Correlation Tool

Universal Deep CNN Pattern Recognition Model



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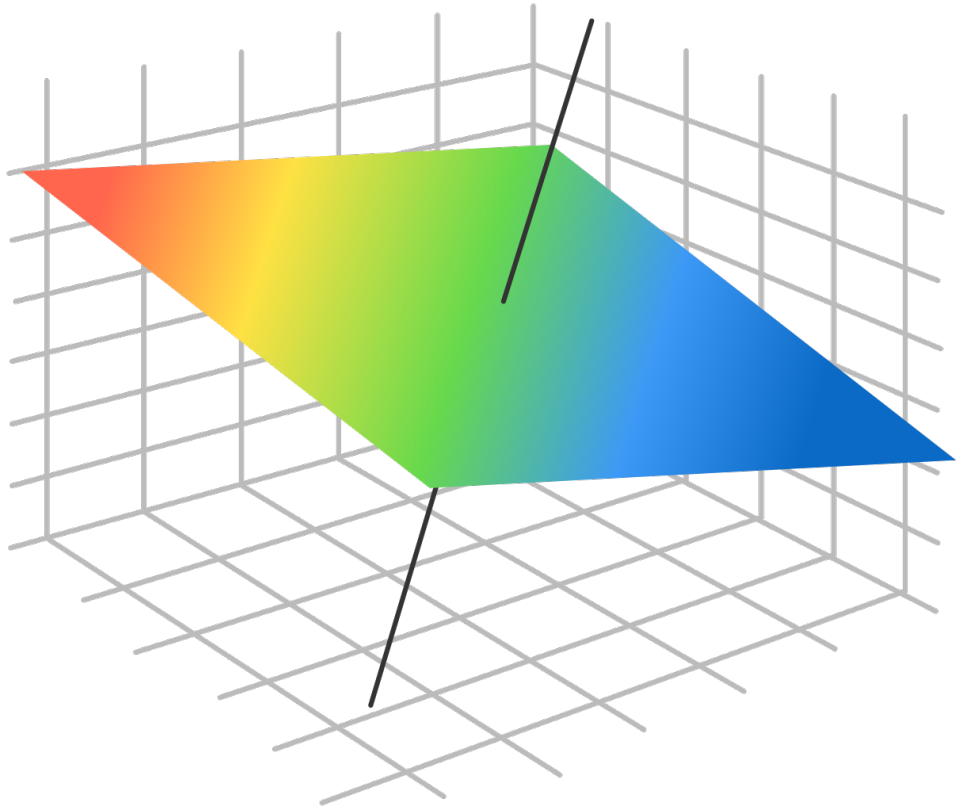
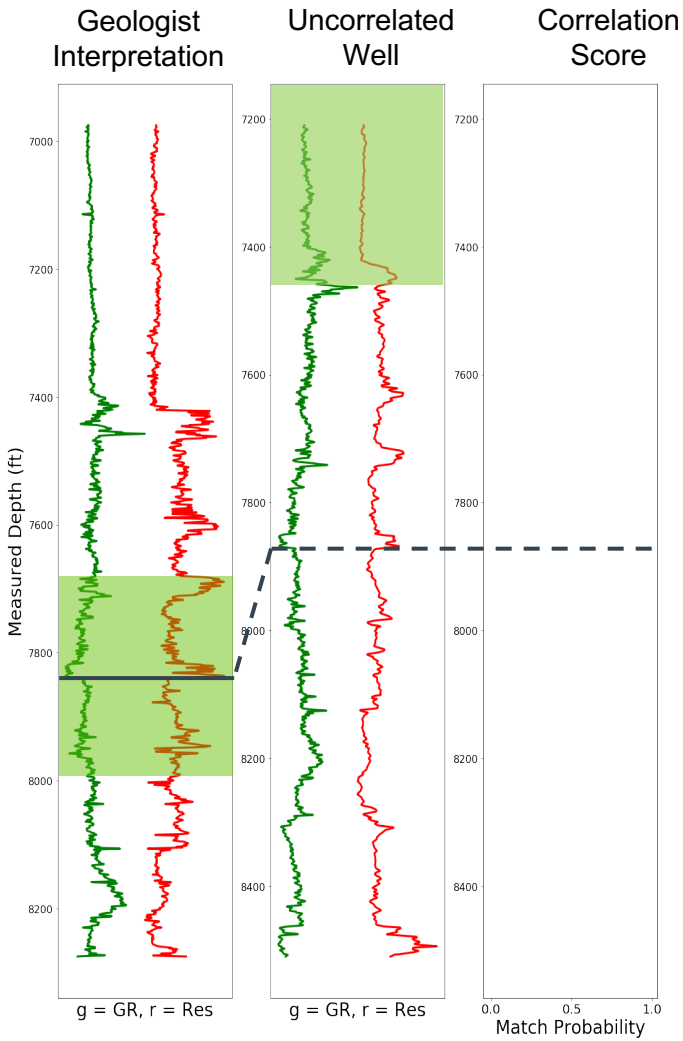
3D Search & Correlation Tool



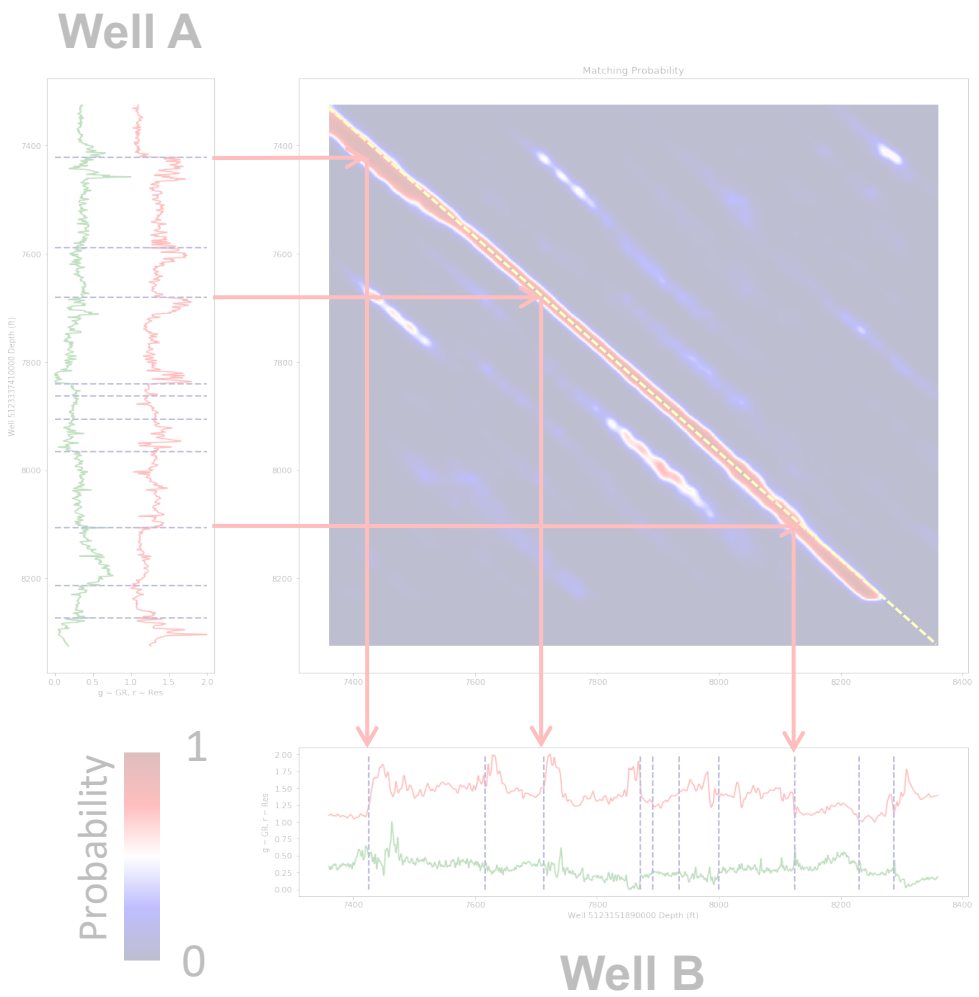
Advanced Methology

Propagation Logic

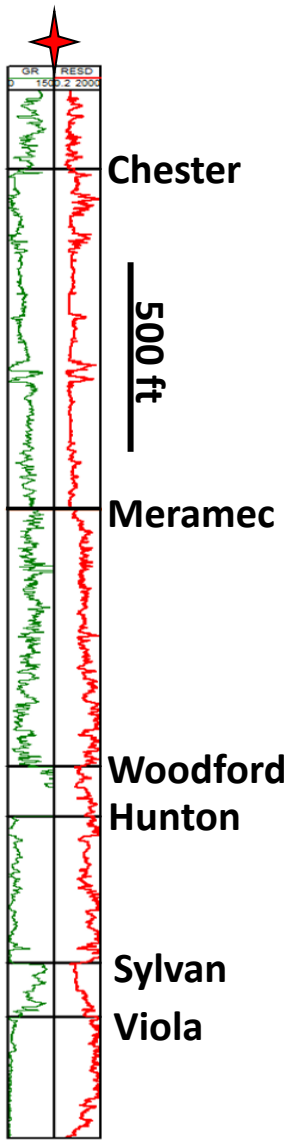
- Tops & comparison distances defined by interpreter
- Incorporates standard correlation rules
- Tops do not cross
- Adheres to structure and isochore statistics
- Minimizes false positives to reduce time spent revewing

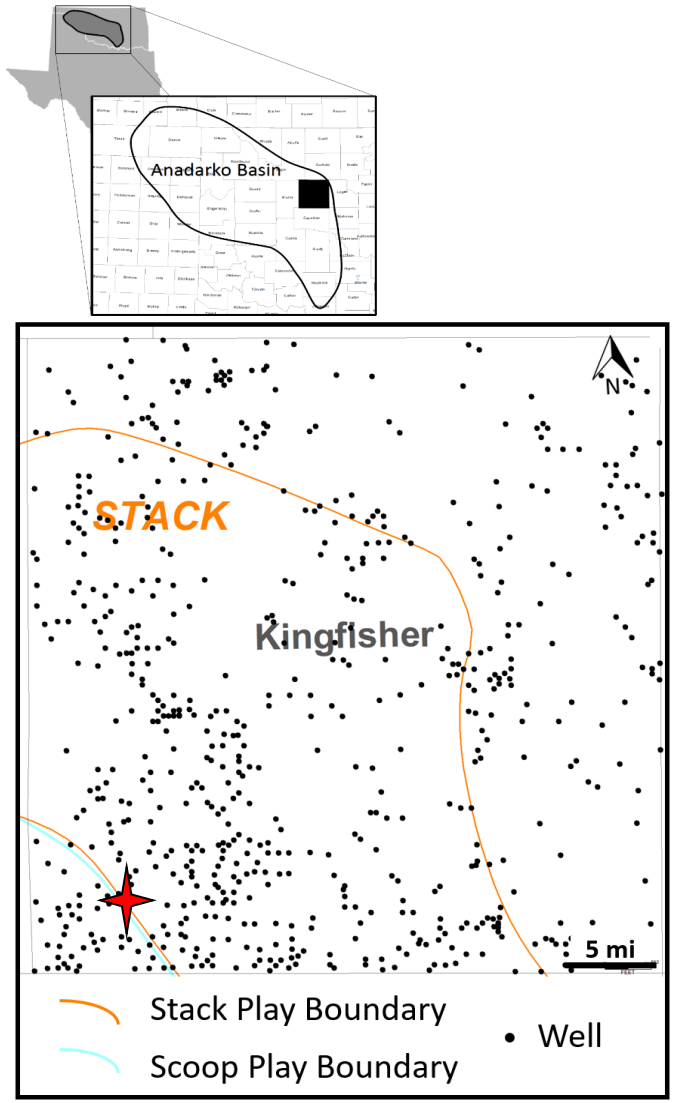


***Distance btwn wells = 4 miles**

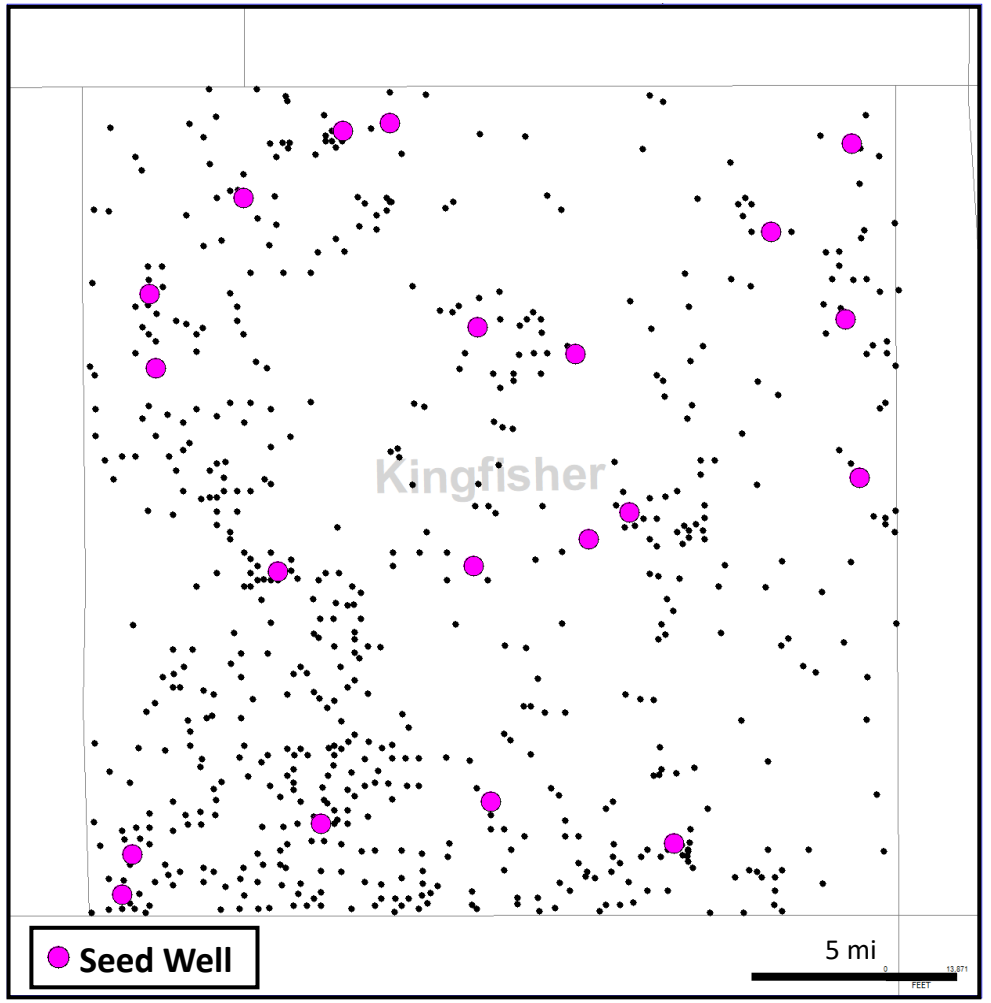


Case Study: STACK Play, Anadarko Basin



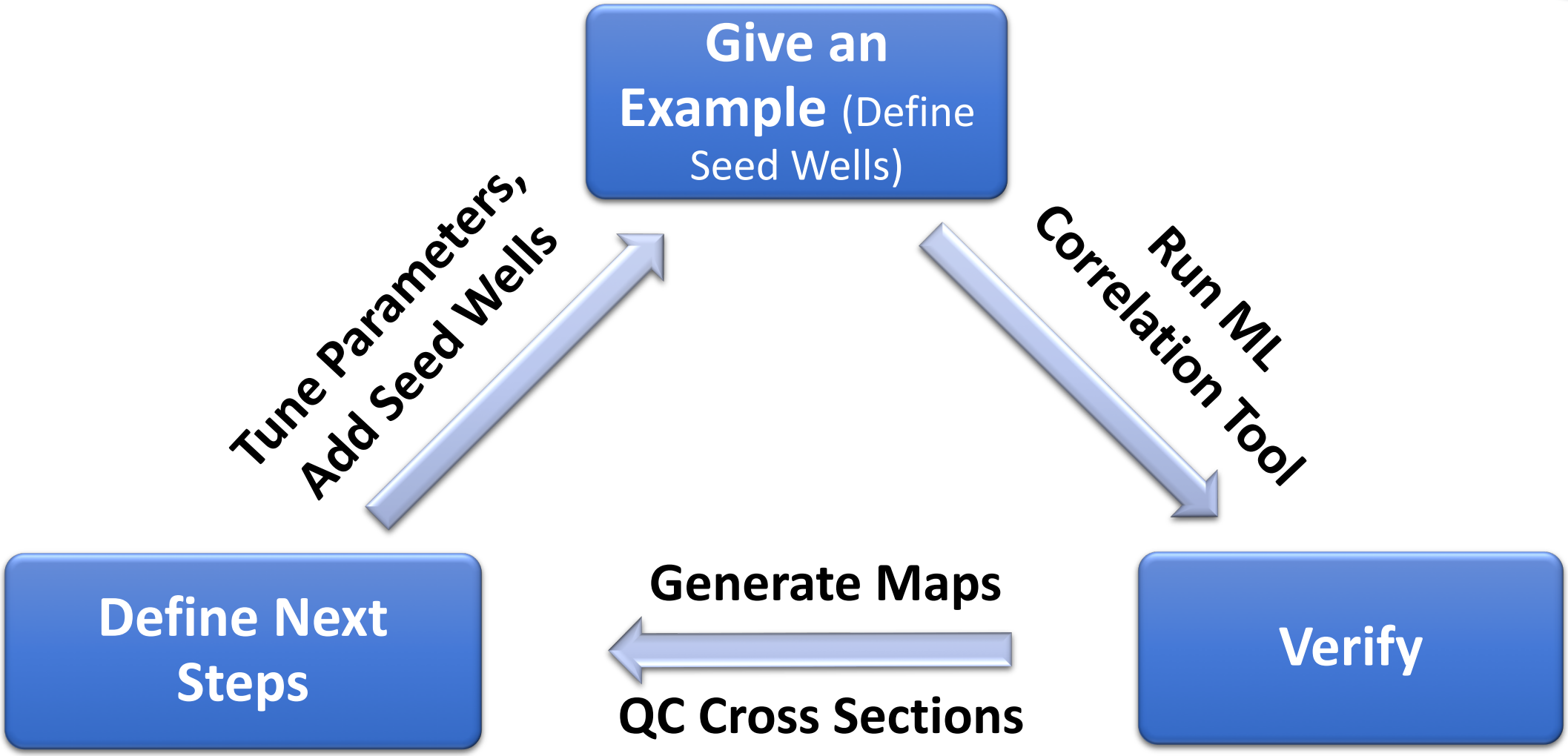


20 Manually Correlated "Seed Wells"



20 Wells Interpreted. 3.6% Data Coverage. 30 minutes

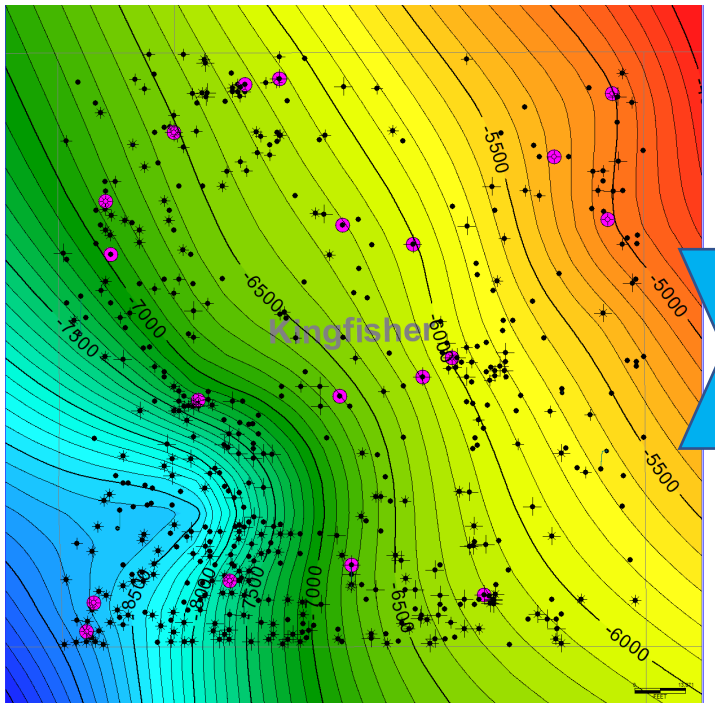
Interpreter-Driven Workflow



Stratigraphic Framework Evolution

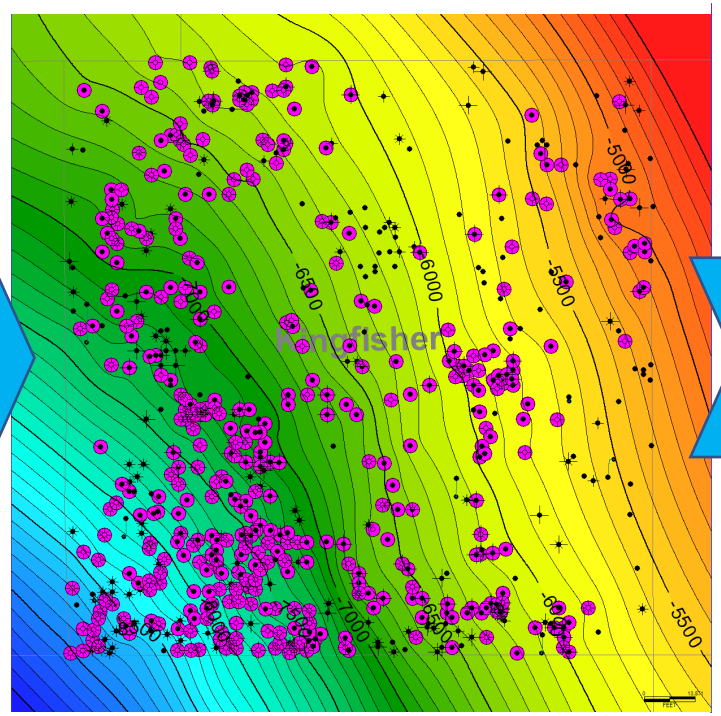
Top of Meramec Structure Maps

Seed Well Selection



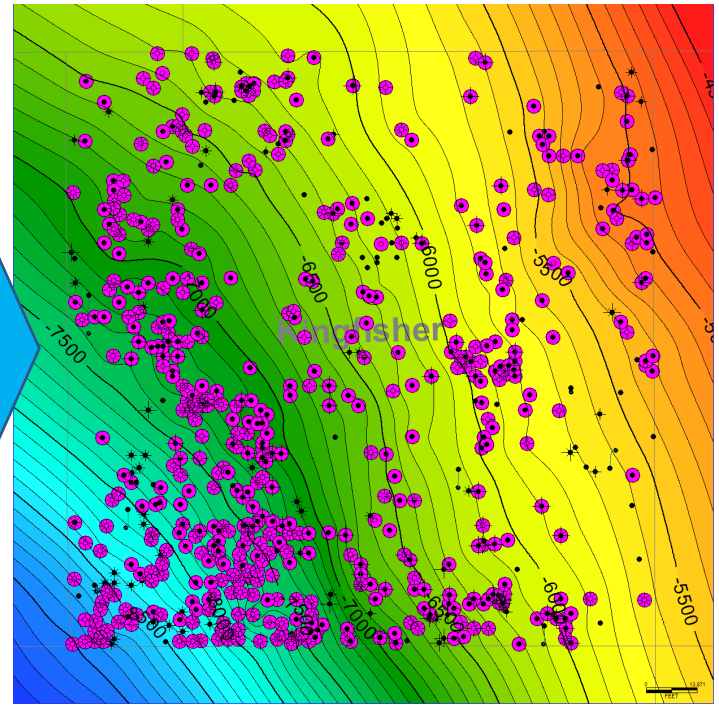
20 Wells Correlated
4% Dataset Coverage
Time 30 Minutes

1st Iteration

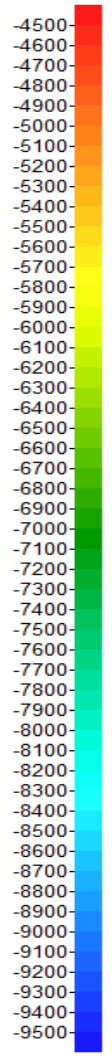


457 Wells Correlated
84% Dataset Coverage
Time 9.5 Minutes

2nd Iteration

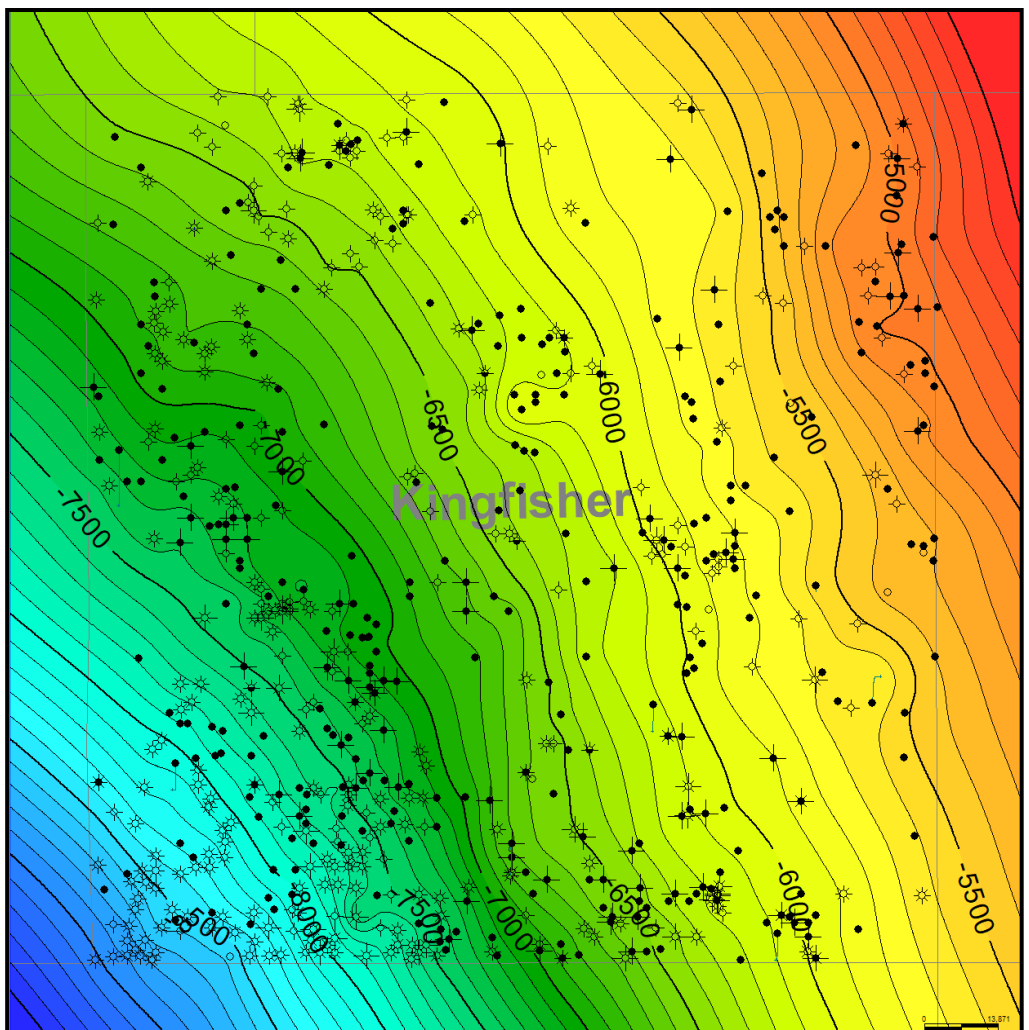


510 Wells Correlated
94% Dataset Coverage
Time 1.7 Minutes

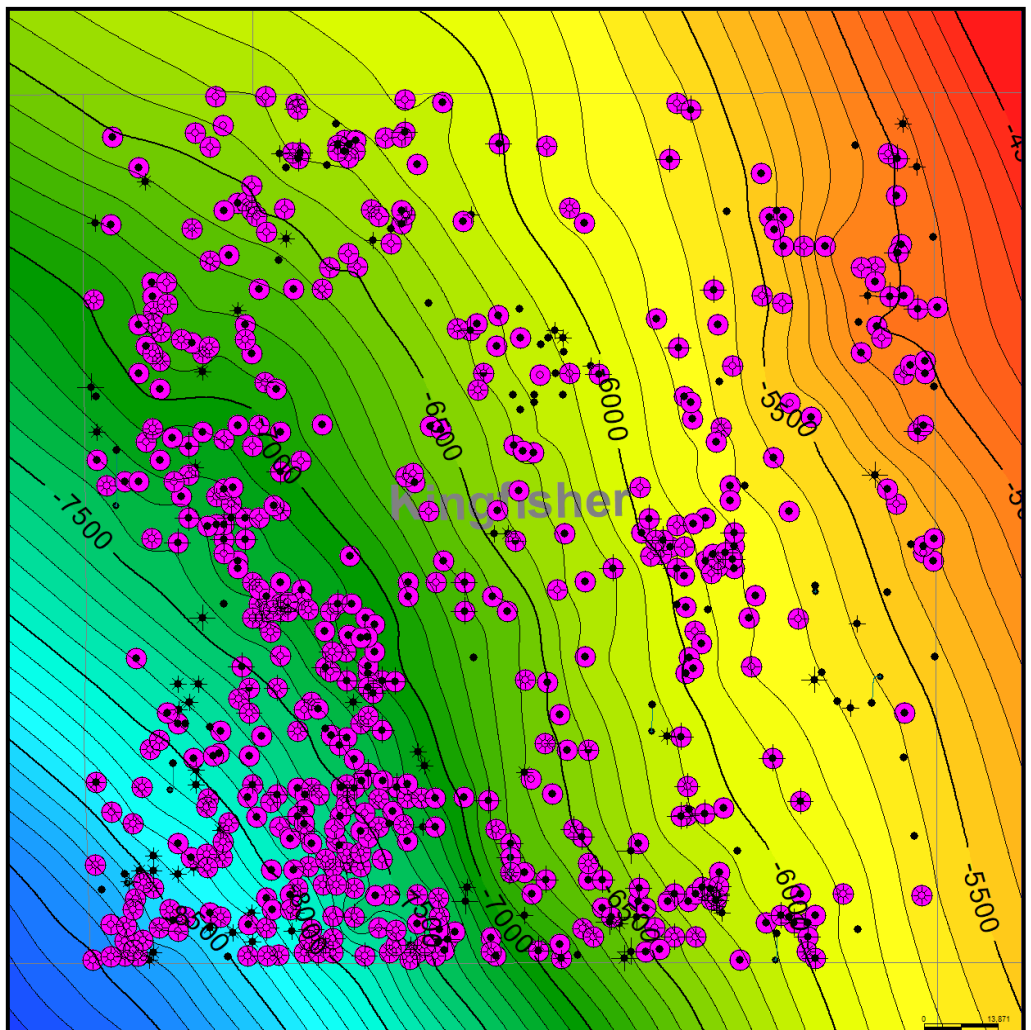


Machine Learning Results: 97% Accuracy

Manually Correlated Meramec Structure

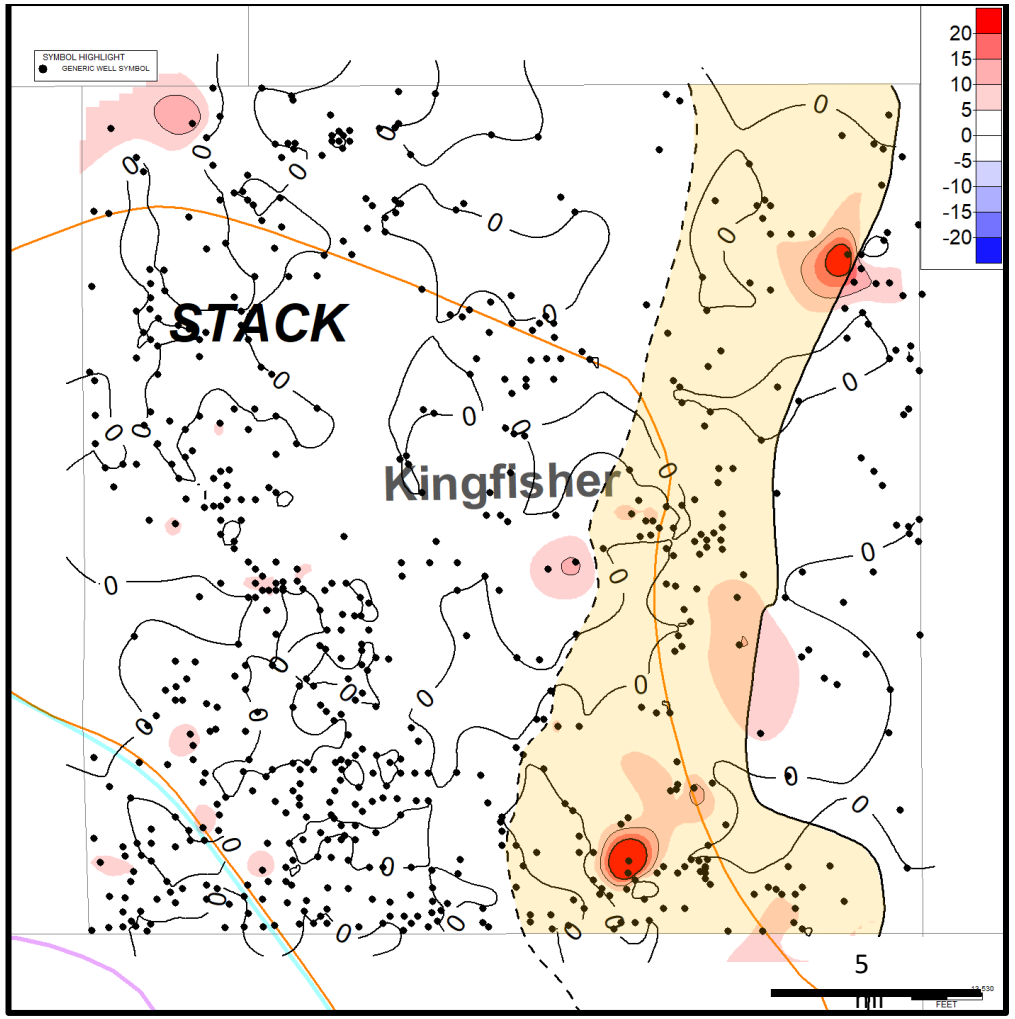


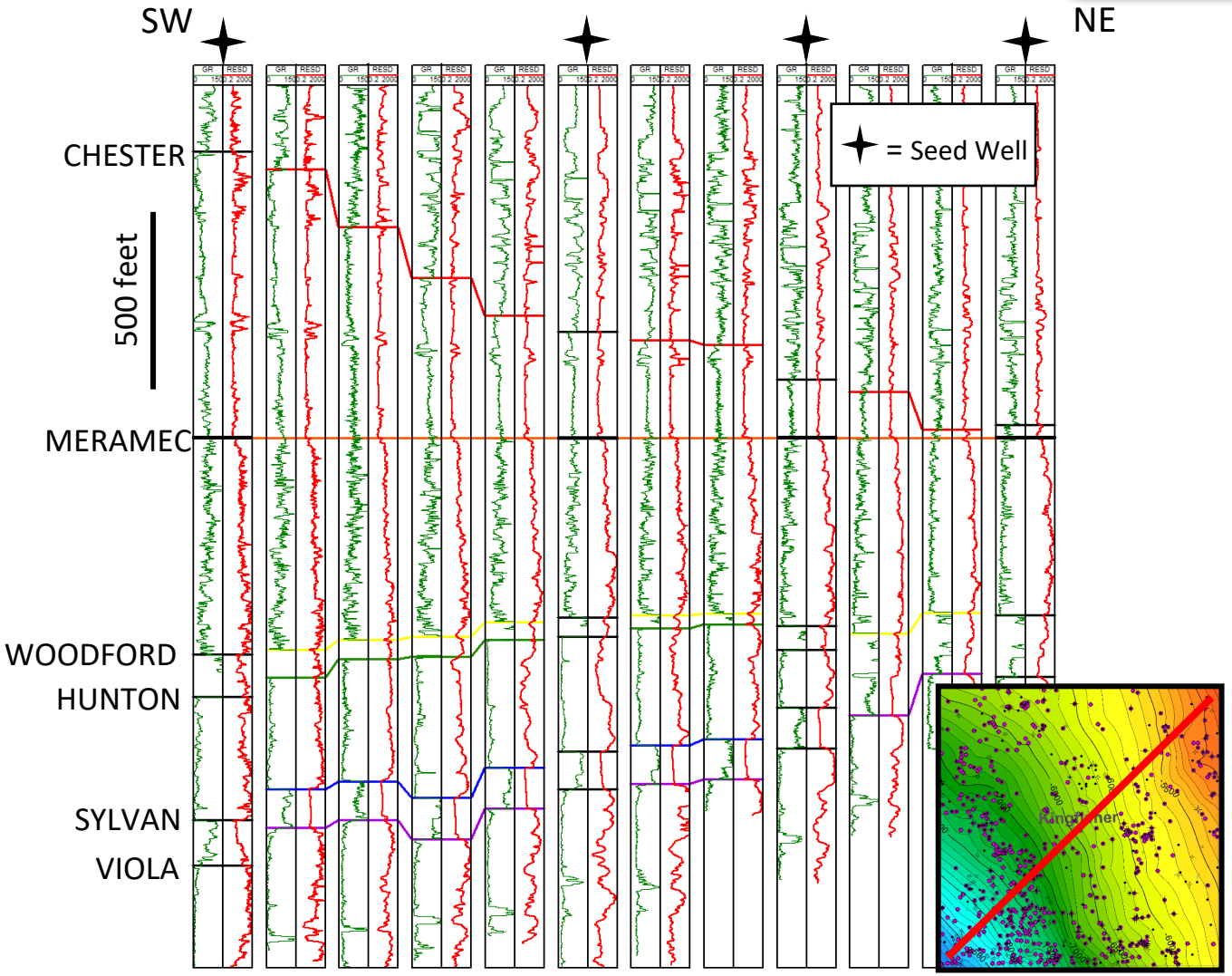
Machine Assisted Meramec Structure



Enabling Interpreters to Focus on Complexity

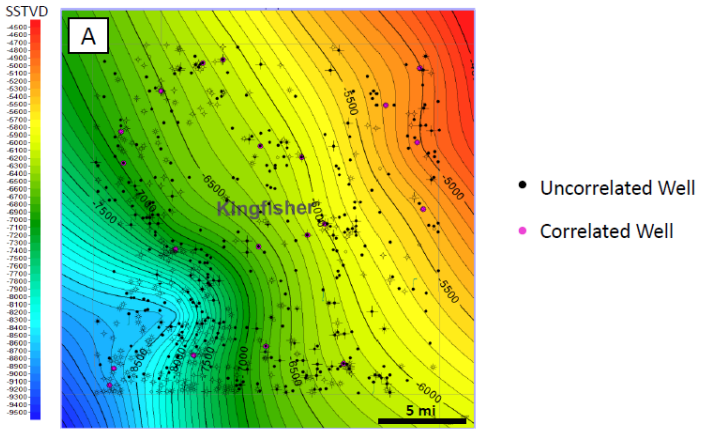
Manual vs. Machine-Assisted Top of Meramec



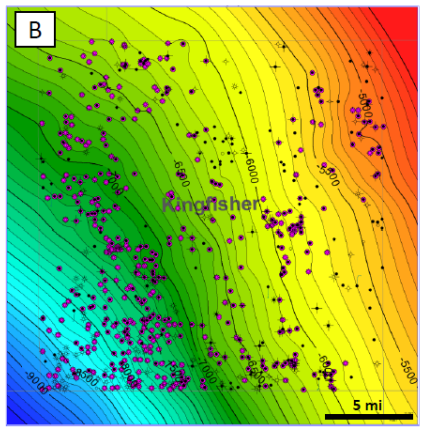


Case Study: Summary

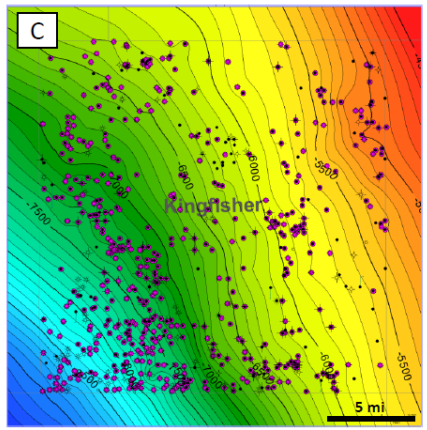
Top of Meramec Structural Map



Correlation Tool Seed Wells
Total Meramec Tops: **20**
% Dataset Correlated: **3.6%**



Correlation Tool Iterations: 1
Total Meramec Tops: **457**
% Dataset Correlated: **84.0%**
Computation Time: **9.45 mins**



Correlation Tool Iterations: 2
Total Meramec Tops: **509**
% Dataset Correlated: **93.6%**
Computation Time: **1.7 mins**

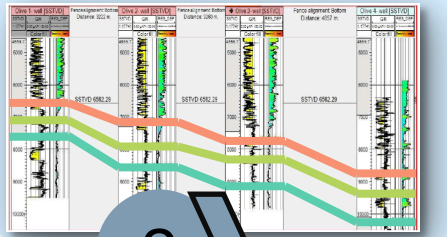
- **Deployed a novel tool for well log correlation**
  - Pattern recognition using deep neural network
  - 3D search window & traditional correlation logic
  - Incorporated SME insights
- **Iterative approach yields robust & accurate correlations**
  - 2 tool iterations
  - 4% to 94% dataset coverage
  - 11 minutes compute time

Leveraging AI to Enhance Reservoir Characterization

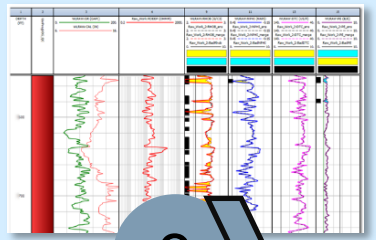
Data Prep

Interpretation & Analysis

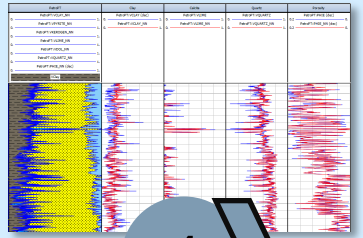
1 Standardization



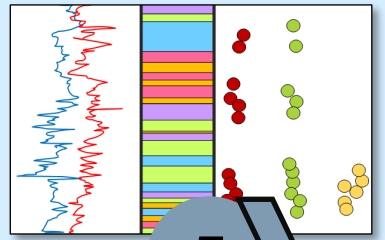
2 Stratigraphic Framework



3 Petrophysical Data QC

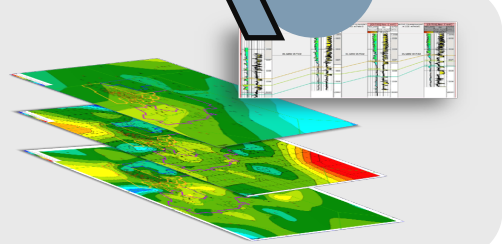


4 Petrophysical Modeling

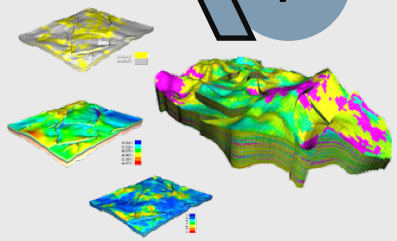


5 Property Analysis

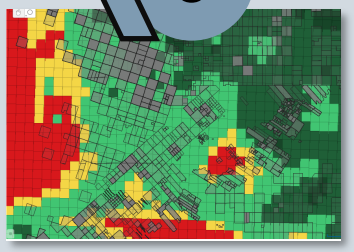
6 2D Mapping



7 3D Modeling



8 Prediction



Value Extraction

Visualization & Analysis

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Thank You