

Geological characterization and modeling of the Cypress Sandstone at Noble Field, southeastern Illinois

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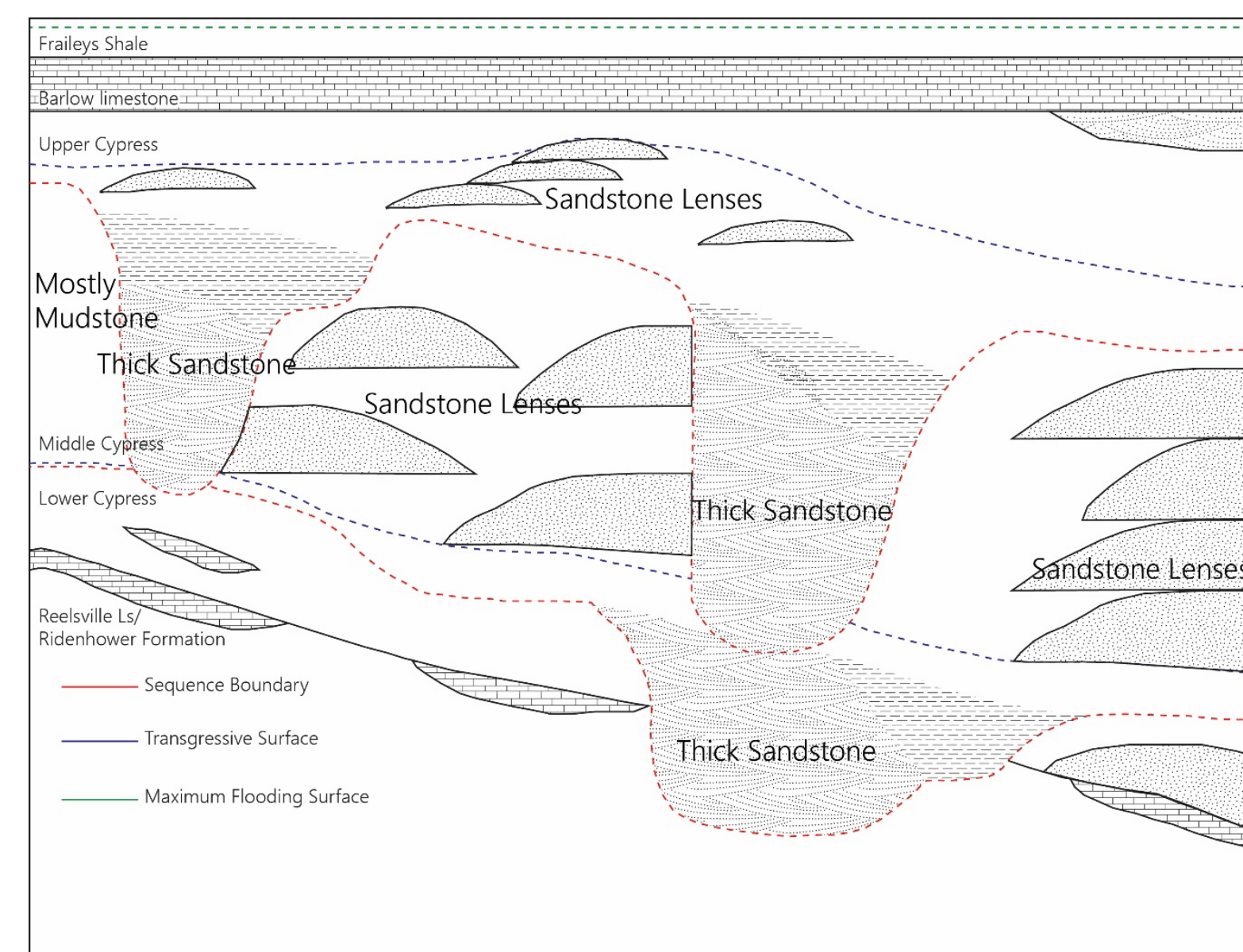
Project Description

A thick Cypress Sandstone fairway, deposited as part of an incised valley fill system that eroded older coastal sediments, lies centrally in the Illinois Basin. The thick Cypress Sandstone can exceed 170 feet and, in places, contains a relatively thin oil reservoir in the top. These oil reservoirs have low primary recovery due to excessive water coning and are an unproduced oil resource in the Basin, but recent horizontal drilling in these zones has had some success. Such reservoirs provide an economic incentive to mitigate greenhouse emissions via nonconventional carbon dioxide (CO₂) enhanced oil recovery (EOR) by storing more CO₂ compared to oil reservoirs conventionally flooded with CO₂.

Detailed geologic characterization of the Cypress Sandstone at Noble Field is underway, leveraging a large and diverse dataset typical of Illinois Basin oil fields to evaluate potential economic CO₂-EOR and storage with aims to extrapolate findings to other areas of the Basin. Geologic characterization, in conjunction with log data from >300 wells, is being used to create a three-dimensional geocellular model that represents the internal architecture of the reservoir for use in reservoir simulations.

Cypress Sandstone Background

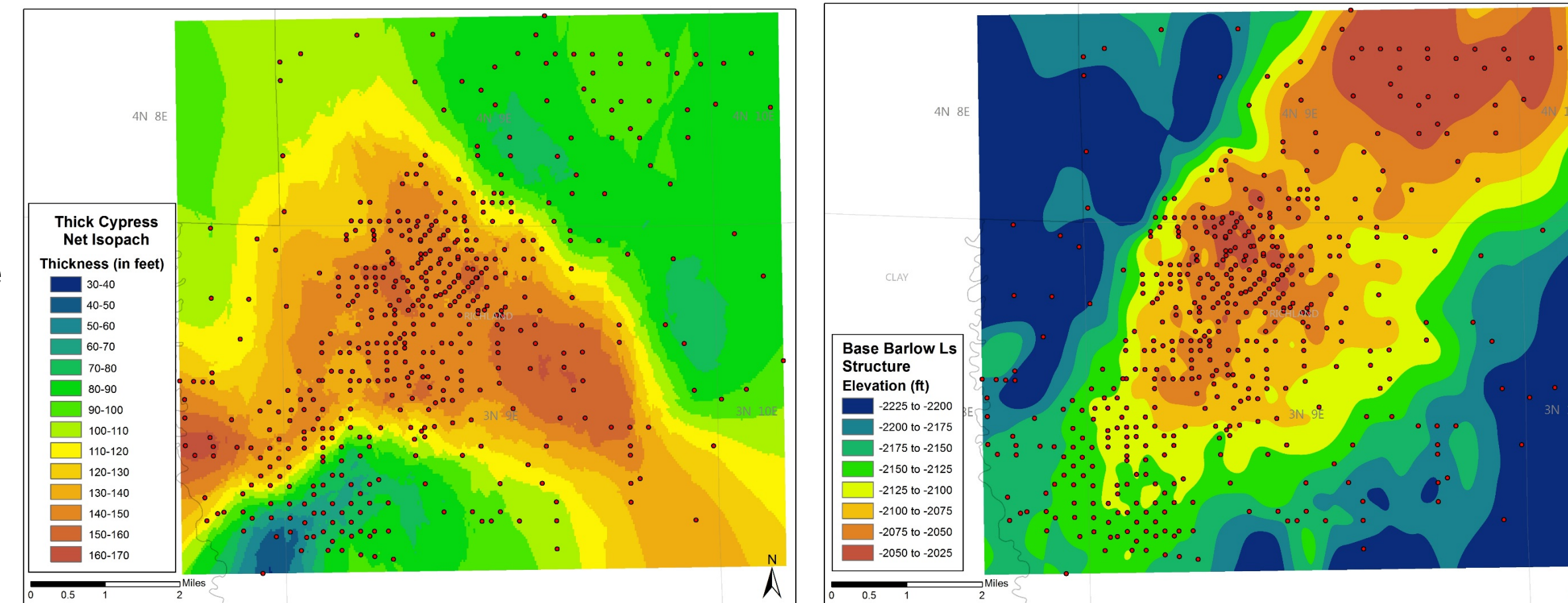
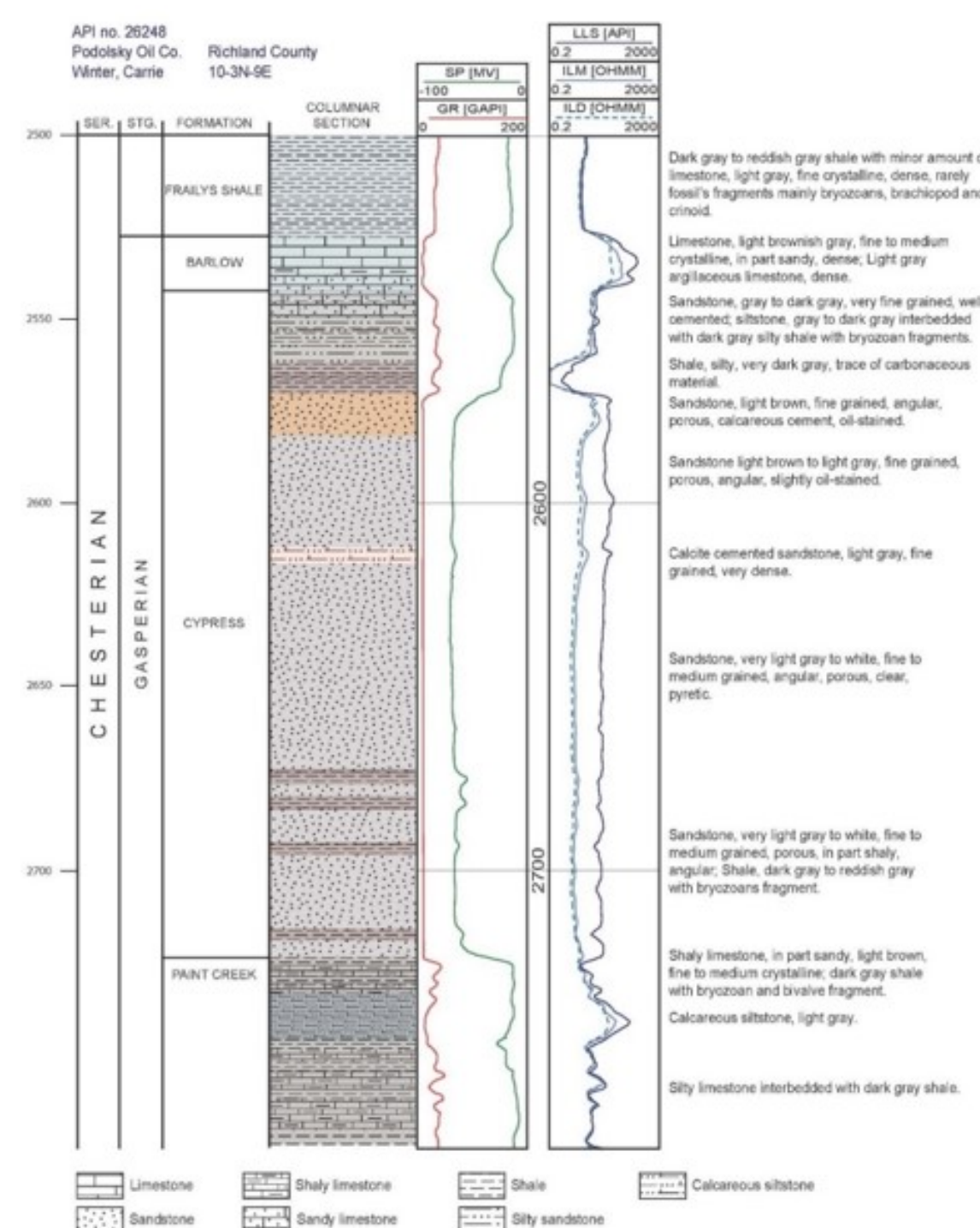
- Multiple sandstone depositional facies
- Production most commonly from tidal bars
- Thick Cypress fairway in the central part of basin
- Relatively thin oil zones above thick aquifer
- Difficulty in producing from thick sandstones due to excessive water
- Nonconventional CO₂-EOR target
- Potential for residual oil zones (ROZ)



Stratigraphic model of the Cypress Sandstone. Figure modified from Webb and Grube 2014.

Noble Field Geology

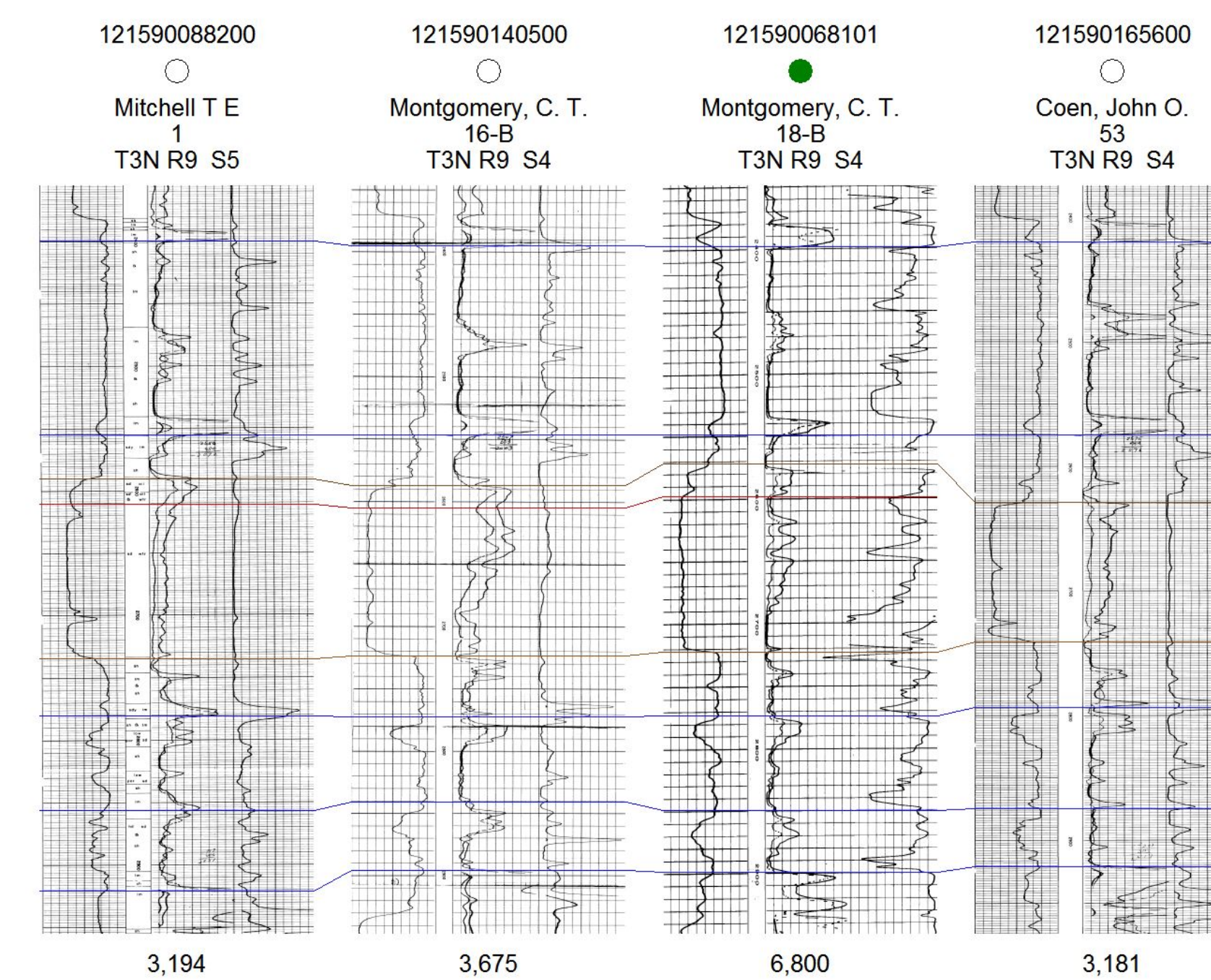
- Located within the thick Cypress Sandstone fairway
- SW plunging nose of the Clay City Anticline (structure map)
- Cypress Sandstone generally very fine to medium grained, fines upward, and can exceed 170 feet thick (isopach map)
- Planar or trough cross bedded sandstone dominates with ripple and lenticular bedded sandstone commonly occurring near the top of the sandstone body



Isopach (left) and structural (right) maps created for the thick Cypress Sandstone at Noble Field.

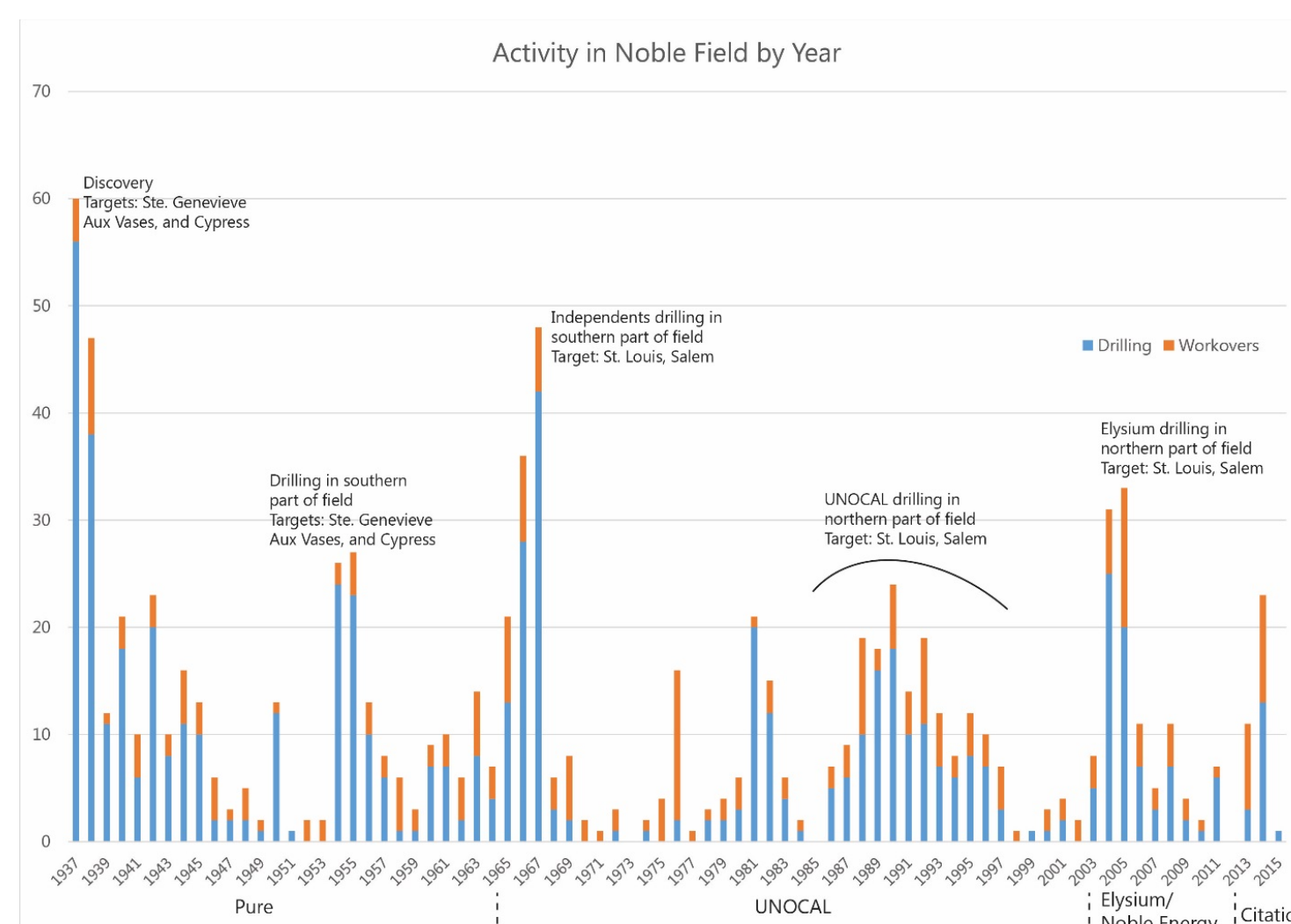
Left: Typical geophysical log from Noble Field with geologic description of the thick Cypress Sandstone.

Right: Cross section showing oil zone, which can reach nearly 60 feet in thickness. Regular shale breaks and calcite cemented zones act as baffles in the reservoir

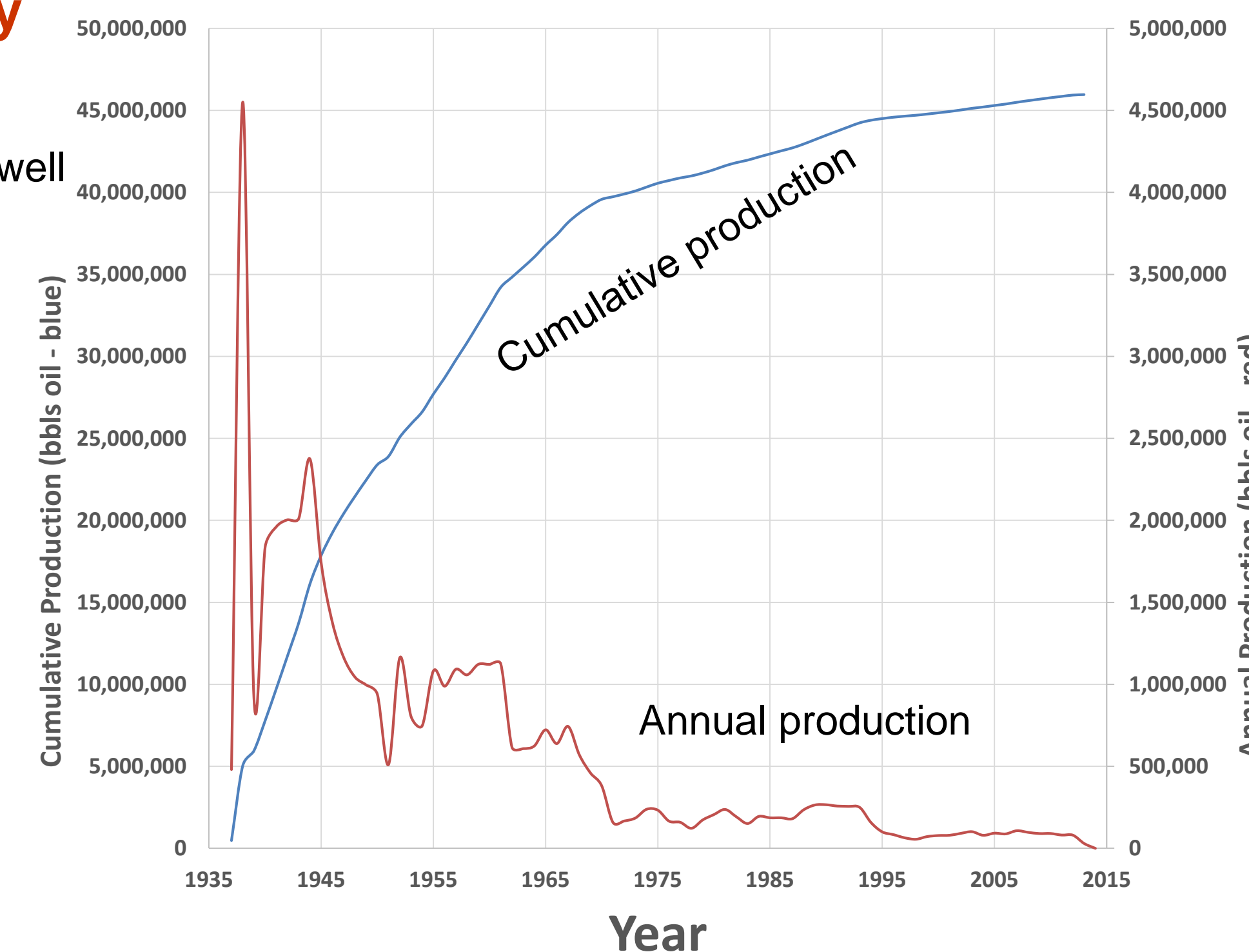


Building the Database - Production history

- Developing database of production history
- 950 wells identified within study area
- Production from thick Cypress is being assigned to each well
- History matching during reservoir simulation provides validation for geologic and geocellular models



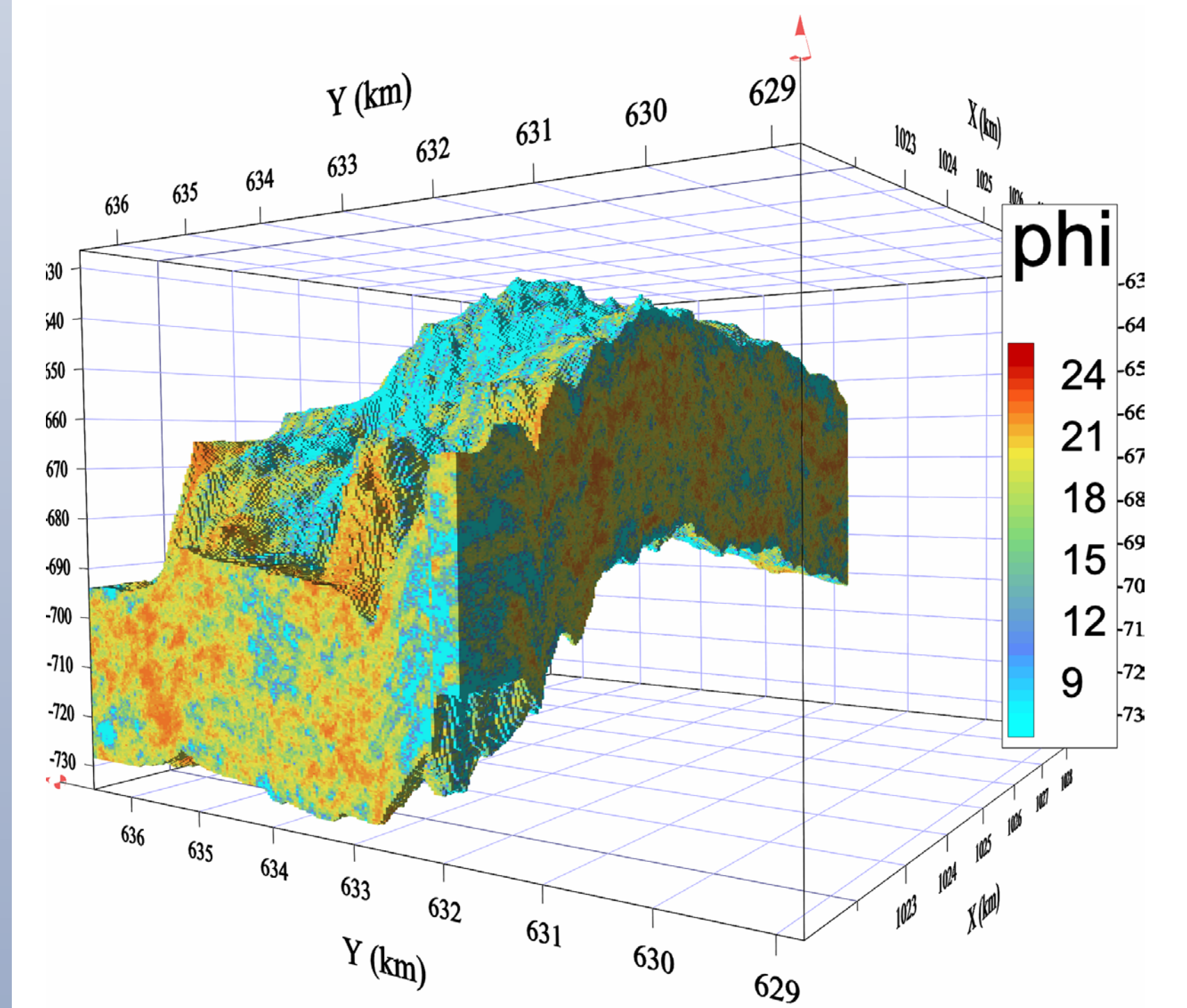
Drilling history was used to determine the relative productivity of all formations



Cumulative and annual production graph for all formations; production is assigned to every well active during each year

Geocellular Models

- Based on structural and isopach maps
- 130 neutron density porosity logs and 385 SP logs used to develop variograms and condition Sequential Gaussian Simulations
- Multiple realizations of the porosity distribution that represent the internal architecture of the thick Cypress at Noble Field
- Porosity to permeability transform being developed using core data



Preliminary geocellular porosity model created from SP logs. Roughly 0.5 x 0.5 mi., 50x vertical exaggeration.

Future Work

- Refined geocellular models
- Reservoir simulations of CO₂-EOR and storage
- Regional correlation and mapping of the thick Cypress
- Extrapolation of findings for regional CO₂-EOR and storage resource assessment

Project staff

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